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STRAITS SETTLEMENTS

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THE

GARDENS' BULLETIN

STRAITS SETTLEMENTS

Vol. V. 3rd JUNE, 1931. Nos. 7 & 8.

ON PERIODIC LEAF-CHANGE AND FLOWERING OF TREES IN SINGAPORE.

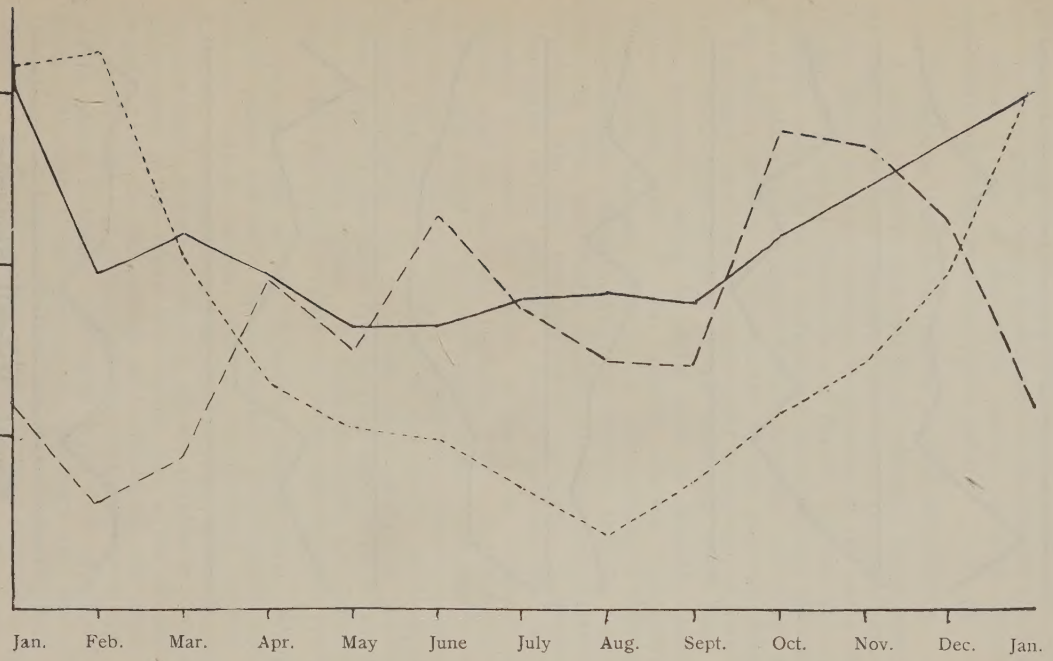
By R. E. Holttum, M.A., F.L.S.

In the year 1905 Wright published an account of his observations on the behaviour as regards leaf change of a large number of trees in Ceylon, chiefly at Peradeniya, from which it appeared that as a general rule deciduous trees changed their leaves at Peradeniya in the dry season in the early part of the year, though many species showed irregularity from tree to tree and from year to year. More recently Coster has published observations on the behaviour of trees in Java, both in the east (which has a long dry season) and in the west (which has a shorter but usually regular dry season about July-August). It appears from Coster's papers that trees in West Java behave much as at Peradeniya, but that leaf changes of trees with annual periodicity take place about six months later in Java, corresponding with a dry season of July-August instead of January-February. Singapore lies between Ceylon and Java and possesses a more uniform climate than either. Moreover, it is obvious even to a casual observer that many deciduous trees do not change their leaves at any fixed season of the year, and that trees of the same species often behave differently from one another. It occurred to me therefore that a careful record of the behaviour of deciduous trees in Singapore would be of considerable interest, and in August 1927 I began a series of observations which has been continued up to the present time. I have to thank my colleagues Mr. E. J. H. Corner and Mr. M. R. Henderson for regularly observing a number of trees during my absence on furlough from June to December 1930; Mr. Corner has also kept records of some species for a longer period. In addition to the leaf changes of deciduous trees, I also made some observations on the flowering of evergreen trees, particularly of fruit trees. It was apparent from the first that the only observations which would be of value were records of the behaviour of individual trees, as different individuals of the same species behaved so

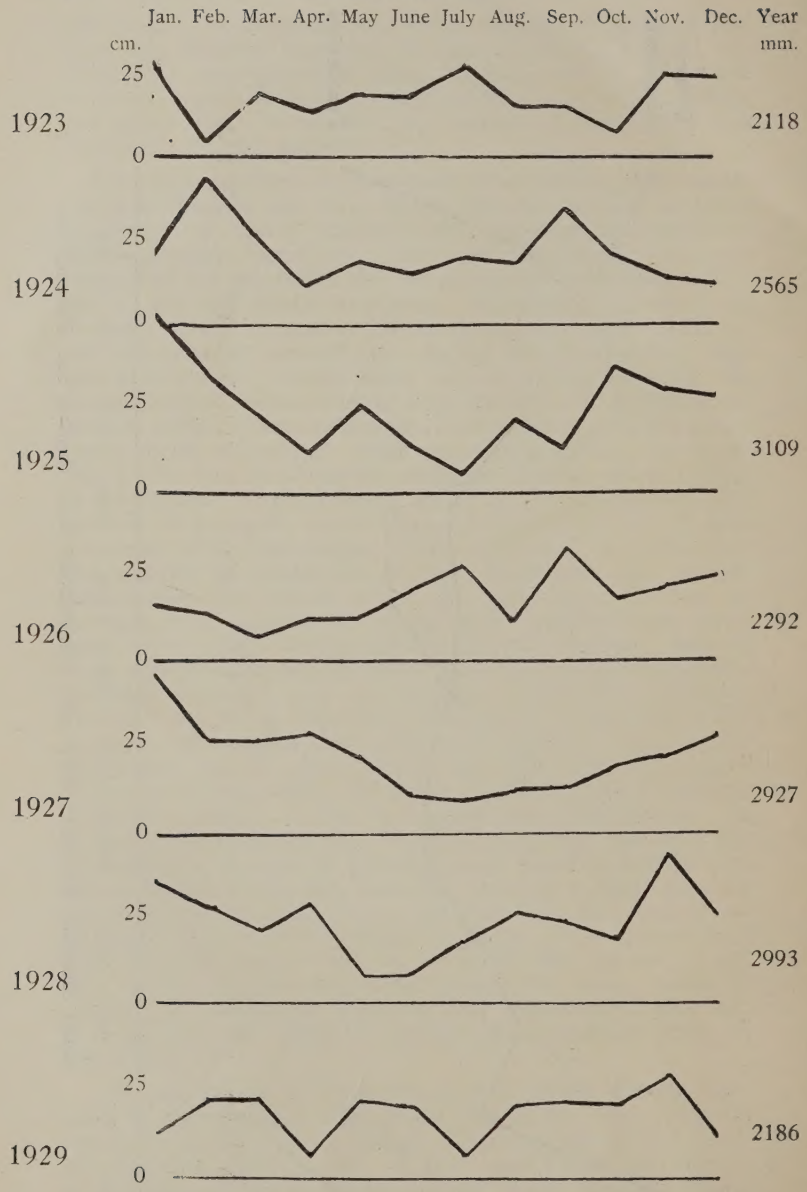
differently. I therefore selected a number of trees in and near the Botanic Gardens, Singapore, which I could see frequently, and inspected most of them weekly. As time went on I found other trees which promised to be interesting and added them to my list; my records of these trees are therefore not so complete.

The temperature of Singapore is so uniform throughout the year that it can have little influence on the seasonal behaviour of trees. Rainfall and atmospheric humidity show greater variation. The one apparently constant feature of the rainfall is the wet season in October-January, during the north-east monsoon. December and January average about 12 inches (30 cm.) of rain each, which is not an excessive amount; but during this season rain falls nearly every day (often light rain over long periods) the sky is nearly always cloudy and atmospheric humidity is usually high. There is usually, but by no means always, a fairly sharp change to drier conditions about February; this is the only well-marked seasonal change which occurs in Singapore. Penang has a much more regular and pronounced dry season about January-February, and in this it agrees with Peradeniya. From February to September the weather in Singapore is very uncertain; dry periods may occur, but rarely any very wet ones. Taking an average of a number of years, these months have each from six to eight inches (15 to 20 cm.) of rain. Indeed, from a graph showing the mean monthly rainfall no definite seasonal changes can be deduced. Individual months, however, are often much drier than the average, and a list of the driest months since 1890 is interesting. There were 18 months in 41 years which had less than 2.5 inches (6.3 cm.) of rain each. Of these months 6 were February, 3 March, 1 April, 5 July, 2 August and 1 September. It is therefore apparent that in addition to the tendency for dry weather to occur in February and March after the wet season of the north-east monsoon, there is a fairly marked tendency for dry weather to occur in July and August, at the time of the driest weather in Java. It is also evident that in some years there is no really dry season at all. The accompanying diagrams show (1) mean monthly rainfall at Singapore, Batavia and Peradeniya, and (2) the variation in monthly rainfall in successive years in Singapore.

It appears to me that the records which I have been able to collect show that many deciduous trees respond regularly to the usual change of season about February by changing their leaves. A few have their leaf change at the time of the other dry period, about August. Some change their leaves at both seasons. Many trees however seem to notice no season, but are a law unto themselves,



Mean Monthly Rainfall : Singapore (continuous line), Batavia and Peradeniya.



Monthly Rainfall, Singapore.

changing their leaves at approximately equal intervals with little or no regard to the time of year. It is particularly interesting to note that some of these species have a regular annual leaf-change in the more definitely seasonal climates of Java and Ceylon. The deciduous trees of Singapore usually stand bare of leaves for a few days only, or the new leaves begin to expand before the old ones are all fallen; a few of the exotic species, such as *Bombax malabaricum*, have prolonged bare periods.

Deciduous trees with regular annual leaf-change.

I have observed individuals of about a dozen species of trees which have changed their leaves regularly once a year. Most of these develop new leaves in the early part of the year, about February and March. These are presumably trees which by nature and surroundings naturally have a leaf-period of about twelve months, and which are kept rather strictly to this period by the seasonal change in February (see remarks below upon senescence of leaves). Each tree varies a little in its behaviour from year to year, probably owing to differences in climatic factors. These trees are of the species *Parkia Roxburghii*, *Tamarindus indicus*, *Cratoxylon polyanthum*, *Terminalia subspathulata*, *Cassia nodosa*, *Pterocarpus indicus*, *Sindora Wallichii* (one tree only), *Kigelia pinnata*, and *Hymenaea courbaril* (the last two are exotic species). *Artocarpus Gomeziana* is not perhaps a truly deciduous tree, but it appears to renew its leaves regularly in February and March, and so may be included here. My records of course only apply to the individual trees concerned and to the period of observation; in some cases I have reason to believe that most or all trees of the species in Singapore behave similarly, but in a few cases (certainly Sindora) other trees of the same species may have periods notably more or less than a year. In some trees also the behaviour may not always be so regular as in the period under review.

Single trees of the following species have changed their leaves annually about August: *Koompassia malaccensis*, *Cedrela toona*, and an unidentified species of *Lecythis*. In connection with the Lecythis, it is interesting to note that a young plant of *L. ollaria*, planted in February 1928 close to the older tree which has a leaf-change in August, lost its old leaves and developed new ones in February 1931. If this small tree continues to change its leaves about February, we shall have two neighbouring trees, one with a leaf change in February and the other in August. It is possible that the time of planting and the climatic conditions during early life may settle the time of change of a tree of about 12 months leaf-period. As Wright has remarked (p. 427) young trees do not become

defoliated during the first few years of their life; the time of first leaf-fall varies with the species. As regards *Koompassia malaccensis*, another large tree of this species near the Gardens has changed its leaves at somewhat irregular periods of less than 12 months, but I have not complete records of its behaviour. This must therefore be reckoned a species in which there is variation from tree to tree.

The trees above enumerated all differ in their particular behaviour; in some the leaf change is rapid, in some it is slow, and the times of leaf renewal vary somewhat from species to species and from year to year. Detailed records are given in the later part of this paper. *Terminalia subspathulata* loses its leaves slowly throughout the wet season of October-January, and then more rapidly until it is bare about March, when the new leaves appear. Kigelia and Hymenaea on the other hand lose hardly any leaves until about February.

Deciduous trees with two leaf-changes a year.

There are four species trees of which I have observed to change their leaves at intervals of approximately six months. Three of these are local species common in Singapore (*Terminalia catappa, Ficus polysyce,* and *Peltophorum ferrugineum*) ; the fourth is *Couroupita guianensis*, of which I only know one mature tree. Of the first two, I have only detailed records of one individual of each; but in February and March 1931 all the trees of these species which I observed were in some stage of leaf-change. I believe that most individuals of these species in Singapore change their leaves about February and again about August, at the times when dry weather is most prevalent. The tree of Couroupita has changed its leaves in March and September. Two mature trees of Peltophorum at the Botanic Gardens have behaved very much as the other trees above mentioned, but other younger trees have been very irregular; in one case at least a short leaf-period was due to insect attack, and possibly the irregularity is due in part to the youth of the trees.

J. J. Smith (1923) observed at Buitenzorg a shrub of *Breynia cernua* Meull. Arg. which lost it leaves on the average every 5½ months, passing through eleven complete cycles in five years. Possibly some of the trees mentioned above do something similar in Singapore, though my observations up to the present do not indicate that this is likely.

Deciduous trees of other leaf-periods.

There are a considerable number of species trees of which have fairly constant leaf-periods which are neither of six nor of twelve months. Such trees may accordingly

change their leaves at almost any time of year, and to some extent independently of climatic changes and at different times in successive years. Moreover, different individuals of the same species, even though growing side by side, do not always agree in their periods. The most conspicuous example of this is *Poinciana regia* (called in Singapore "flame of the forest"), trees of which may be seen flowering at almost all times of the year. There is no simultaneous flowering of all trees of the species as occurs in countries with a regular pronounced dry season; in such countries the trees must have a leaf-period of twelve months, whereas the tree of which I have records in Singapore has a period of nine months, and the general appearance of other trees in Singapore suggests that they have periods of comparable length. Other species which behave in this way are : *Adenanthera pavonina, Anisoptera megistocarpa, Bombax insignis, Bombax malabaricum, Cassia fistula, Cratoxylon formosum, Dyera laxiflora, Entada spiralis, Ficus religiosa* and *Lagerstroemia speciosa.* With the exception of the species of Bombax, all these trees produce new leaves within a few days of the fall of the old leaves. The lengths of successive periods of the same tree vary somewhat, probably owing to climatic conditions, but on the whole the lengths of such periods are remarkably uniform.

Coster (1928, p. 6) mentions a few similar cases in Java.

Anomalous cases

The most interesting anomalous case is that of *Hevea braziliensis.* It is well known that this species in seasonal climates loses its leaves ("winters") in the dry season, and in the north of the Malay Peninsula wintering is very regular in the early part of the year. In the south of the Peninsula wintering is much less regular. In Singapore many trees every year renew their leaves about February and March; but rarely do all the trees change together as in the north. In some years at least many trees change their leaves in July and August, and often odd trees or individual branches only may be seen with new leaves at other times of the year. Two well grown trees which I have observed in the Gardens are of considerable interest, in that they have altered their time of complete leaf change from August to March, in the interval showing partial changes (a branch at a time) only. I think that the probable explanation is that every rather pronounced dry period causes some leaf-fall, each tree responding differently according to its particular nature, situation and previous history. If a tree has experienced a complete leaf renewal, a subsequent dry period occurring a few months later may cause a partial renewal; subsequent dry periods may again cause partial or complete renewals according to circum-

stances. That there is considerable difference in the response of different individuals is indicated by the behaviour of two younger trees, one of which has passed through two periods of 13.3 and 12.7 months; the other has never experienced a complete leaf renewal during 3½ years. A tree of *Jacaranda filicifolia* has also behaved like the last-named tree of Hevea; it has never lost all, or nearly all, its leaves before flowering, like most other trees of the species, but has flowered on various branches from time to time throughout the year.

The two species of Sterculia (*S. carthaginis* and *S. macrophylla*) have exhibited irregular leaf-periods, and also one tree of *Sindora Wallichii*. A tree of *Ficus glabella* has shown the curious phenomenon (seen also in *Eugenia grandis*) of three unequal leaf-periods in each year, the periods being of approximately 3, 4 and 5 months.

The senescense of leaves.

With the exception of the trees mentioned in the last section, these observations indicate the probability that the majority of deciduous trees in Singapore have fairly constant leaf-periods. The idea which suggests itself as an explanation of these phenomena is that of senescence of leaves; that the leaves of a given tree are so constructed and related to the rest of the tree that they will function for approximately a given period, and then become too old to be efficient and so need to be changed. There are doubtless many factors which determine the rate of senescence; it is possible that this rate varies with the age of the tree. The common heriditary characters in each species will determine the leaf period approximately, but for each individual there is some chance of individual peculiarity due to small hereditary differences and local differences of soil and situation; the final result is due to the interplay of internal and external factors, as Coster has observed (1923, pp. 182-183). In Singapore the climate is such that there is never a time when the heat or drought is so intense that a tree cannot carry leaves; therefore trees which have a natural tendency to a leaf-period which is not annual have a free scope to display their peculiarities, which are kept in check in countries which have strongly seasonal climates. I suggest however that there is enough of regularity in the seasons of Singapore to keep some trees which have a tendency to an approximately 12 month period to exactly that period; similarly for trees with 6 month periods.

It is probable that in all cases climatic variation from year to year influences to some extent the time of leaf-fall and leaf-renewal, but that some species of trees are much more susceptible to climatic influence than others. *Hevea*

braziliensis is probably a species the trees of which are very much influenced by climatic variation, though there must also be considerable individual differences of response, depending partly on the previous history of each tree. Coster's observations on the behaviour of teak trees (*Tectona grandis* L.) and of *Bombax malabaricum* in east Java (1923, pp. 140, 147 and 161-172) indicate that the teak tree is very susceptible to differences of climate and of water supply, whereas the resting period of Bombax is much less dependent on climatic variation and can with difficulty be influenced experimentally. In Singapore teak trees are never bare of leaves, responding to our uniformly moist climate; but Bombax trees maintain their habit of a long resting period. The leaves of Tectona and Hevea have apparently a less definite life period. Such species appear to be in the minority among deciduous trees.

There are some species which are on the dividing line between deciduous and evergreen; such are those trees which regularly lose their old leaves as soon as the new ones have grown or while they are growing, of which *Artocarpus Gomeziana* is an example. Some trees which are normally truly deciduous occasionally come into this class, producing new leaves before the old fall; examples are *Dyera laxiflora* and *Sindora Wallichii*. But most true evergreen trees differ from deciduous trees in not losing their old leaves as soon as the new ones are grown; the old and the new persist together and the old fall gradually at some later time, but I think not usually all together. It is impossible without marking individual leaves to tell how long such leaves may last; some must have a very long life, probably of several years. Most trees of this truly evergreen type have flushes of new leaves from time to time, some at intervals of a few months and some at rather long intervals (e.g. the mangosteen, *Garcinia mangostana*). I have not any adequate observations on the leaf renewal of such trees. The tembusu (*Cyrtophyllum peregrinum*) seems to be making new growth slowly throughout the year; I have never noticed a tree without some new leaves on it. The fact that leaves of evergreen trees coexist during the later part of their life with one or more successions of younger and probably more active leaves would probably tend to reduce the activity of the older leaves and so to make less definite the actual time at which a leaf becomes so old as to be useless to the tree; it is likely therefore that the individual life of leaves of evergreen trees is of less definite duration than the life of leaves of deciduous trees.

The evergreen fruit trees.

The trees which bear the principal seasonal fruit crops in Malaya are evergreen. Of these the chief are the Durian, the Mangosteen, and the Rambutan. Observations

have been kept of the flowering and fruiting of these three species in Singapore since 1927. Some observations have also been made of their leaf production; they all produce crops of new leaves at intervals of a few months (the mangosteen at longer intervals than the other two) and I could find no regular relation between the production of new leaves and flowering or fruiting in any of them. There are two principal flowering seasons, about March and September, for all three, followed by fruit seasons about July and January. For durians and mangosteens the July fruit crop is usually the heavy one, that in January being only small; but if the July crop fails the January one may be heavy. Rambutans seem to fruit heavily in January more frequently. In west Java, with a dry season in July-August, the fruit season is December-January; in Penang, with a principal dry season in January-February, the chief fruit season is June-July. Singapore, having two not always very strongly marked dry seasons, has two fruit seasons; but there may be 18 months or even two years between heavy fruit crops, and small crops occasionally occur at odd intervals. The production of flower buds is apparently dependent upon dry weather.

Evergreen trees showing regular periodicity of flowering.

For most evergreen trees other than fruit trees I have no regular records of flowering. Whenever there is a pronounced dry period early in the year a number of such trees come into flower; probably many of them resemble the fruit trees in their behaviour. I noticed that several large trees of Shorea spp. in Singapore flower only once in several years.

There are two species of evergreen trees which are largely used ornamentally in Singapore and which exhibit regular and gregarious flowering; these are *Cyrtophyllum peregrinum* (tembusu) and *Eugenia grandis* (jambu laut). The tembusu has flowered heavily in April-May in three successive years (1928-1930), and I believe also in previous years, though I have no written records. The trees also have flowered again less freely in October-November. Some trees flower on odd branches at other times; a few also have been noticed to flower less heavily in May and more heavily in November; but the majority behave as stated. The flower buds are slow in development, and it is possible that the dry season of February-March provides the stimulus to their development. The trees are usually so heavily loaded with fruit in August and September that only a small flowering in November is the natural result. It would be interesting to know whether the later flowering is ever the heavier one.

The flowering of *Eugenia grandis* is more frequent. In the past few years there have been three general flowerings each year of the majority of trees on Singapore Island. Some flowerings have been heavier than others, but there is no regularity as to the season of heaviest flowering. Individual trees vary somewhat, but the majority keep rather closely together. In some cases the periodicity has been upset by heavy pruning of the trees. The times of flowering have been at unequal intervals, but about the same in each year, namely March-April, July-August, December-January, giving intervals of 4, 5 and 3 months respectively. Some detailed observations will be found summarised on p. 191. In every case the trees produce new leaves and flowers together, but sometimes more leaves and sometimes more flowers are produced. It is probable that this species is in some way dependent on annual climatic changes for the maintenance of the regular flowering year by year, but it is not at all clear what these changes are. The case of *Ficus glabella* is a comparable one.

Orchids with periodic flowering.

In addition to the smaller orchid species which are dependent for their flowering on sudden local climatic changes (such as *Dendrobium crumenatum;* see Coster 1926) there are many larger kinds which appear to be dependent on seasonal climatic changes. Two such species are the very large *Grammatophyllum speciosum,* and the common scorpion orchid, *Arachnis moschifera.* The flowering of Grammatophyllum usually corresponds with the fruiting of the durian trees. It is possible that the dry seasons which stimulate the durian trees to produce flower-buds have the same effect on the Grammatophyllum plants, but that the inflorescences do not develop until wet weather has followed the dry season. Like the durian, this orchid species seems to flower in Singapore usually at intervals which are multiples of six months.

Arachnis moschifera is a stout climbing plant. It has produced two crops of flowers each year from 1927 to 1930, at the same times as the flowering seasons of the tembusu (Cyrtophyllum). Presumably it reacts similarly to seasonal changes.

RECORDS OF INDIVIDUAL BEHAVIOUR.

Adenanthera pavonina L. Saga.

South-eastern Asia.

Wright observed (p. 504) that at Peradeniya this species had an annual leaf-fall, and a leafless phase of 22 to 38 days, usually in November and December. The tree regained its foliage very slowly, and was rarely in full leaf before the end of February.

In Singapore I observed a well-grown and vigorous tree from August 1927 onwards. Its leafless phases are always very short, and the tree is usually well covered with leaves in a fortnight from the time when the first leaf buds open. There is always a full flowering with the new leaves, and a good crop of fruit. The appearance of the new leaves provides a definite point in the leaf-cycle for purposes of comparison. New leaves appeared on the following dates:

Date	Interval
27.8.1927	
22.3.1928	6.8 months
21.10.1928	7 months
28.4.1929	6.2 months
8.12.1929	7.3 months
21.8.1930	8.4 months
10.3.1931	6.6 months

July and August 1930 were exceptionally dry (only 76 mm. of rain in the two months); this possibly accounts for the lengthening of the leaf period ending August 21, 1930.

Anisoptera megistocarpa van Slooten.
Malaya Peninsula and Sumatra.

There is a fine tree of this species in the Gardens Jungle at Singapore. Leaf-fall takes place gradually during several months; the new buds open about the time the last old leaves are falling. I have not observed flowering on this tree. New leaf buds were observed to be opening on August 18th 1928, and again on December 8th, 1929, a period of 15.7 months. The old leaves fell gradually towards the end of 1930 and new leaves began to expand about March 12th 1931, completing a second period of 15.1 months.

Arachnis moschifera Bl. Scorpion orchid.
Malaysia.

This orchid, a quantity of which is grown in the Singapore Botanic Gardens, flowered profusely twice a year in 1927-1930, in the months of May and November. In this it agreed with the trees of *Cyrtophyllum peregrinum*, though the latter flowered much less heavily in November than in May.

Artocarpus Gomeziana Wall. Tampang.
Malaya, Tenasserim, Andamans.

Trees of this species produce new leaf shoots before the old leaves fall; the old leaves are all fallen by the time that new growth is complete. Fruits are borne on the

new shoots. An old tree of this species has been under observation since 1927. In each of the years 1928 to 1931 this tree has begun to produce new leaf shoots in February, usually branch by branch, and the new growth has continued on some branches for two or three months. In 1930 two large branches died, and in 1931 the whole remaining part of the tree produced new leaves simultaneously in February and March. Three other younger trees in the Gardens, not near the old tree, have changed their leaves at about the same time in the past two years.

Bombax insigne Wall.

Lower Assam and tropical Burma.

A young tree of this species (probably about ten years old) is planted in the Singapore Botanic Gardens. The leaves remain green for about four months, and then turn yellow and gradually fall; the tree stands bare for 3½ months or more before the new leaf buds open. The amount of rain falling during the bare periods seems to have no influence on their duration. The observations of this tree are as follows:

leaves fallen	new leaves	leaf period
3.12.1927	17.3.1928	
15.8.1928	16.12.1928	9 months
15.5.1929	1.9.1929	8.5 months
12.1.1930	3.5.1930	8.1 months
1.9.1930	10.10.1930	7.2 months
10.12.1930		

Bombax malabaricum DC.

India to southern China; southwards to Ceylon, the Philippines and north and east Australia.

Wright (p. 436) records that at Peradeniya this tree is usually bare from January until April, flowering in January and February, and ripening its fruits in April. Records of the leafless phase varied from 32 to 96 days (p. 500).

In East Java the trees are all bare for several months (Coster, 1923 p. 140), and also at Buitenzorg they are usually bare from July to October, the new leaf buds opening somewhat earlier than in east Java (Coster, 1927 p. 108).

In Singapore I have observed two young trees (about twelve years old) growing side by side, and of about the same height. They are planted upon a slope, one a little higher than the other. The upper tree has had until 1931 longer leaf-periods than the lower one, as will appear

from the following record. In both trees the periods have been much less than a year.

	leaves fallen	new leaves	leaf period
upper tree	30.12.1927	30.3.1928	
	11.11.1928	17.2.1929	10.6 months
	15.9.1929	18.12.1929	10.0 months
	1.8.1930	1.11.1930	10.4 months
lower tree	29.1.1928	20.3.1928	
	14.10.1928	16.12.1928	8.5 months
	14.7.1929	6.10.1929	9.7 months
	14.4.1930	10.6.1930	8.1 months
	1.2.1931	3.5.1931	10.8 months

Cassia fistula L.

India.

Wright records (p. 504) that this species at Peradeniya has a short leafless period during the dry season in January and February.

Coster (1927 p. 81) records that in east Java it is bare for about two months, the young leaves often appearing before the rains begin; it flowers with the new leaves. At Buitenzorg it is very irregular, but apparently it usually changes its leaves, often branch by branch, during the dry season, without becoming bare, and flowers on until January; it may also flower somewhat in April and May.

In Singapore also trees of this species lose their leaves rather irregularly, but usually there is a fairly well-marked leaf-fall (sometimes branch by branch) followed by a general flowering with the young leaves. It seems possible that some trees have a leaf period of about 12 months, but the two trees of which I have records, in the Botanic Gardens, have both had definite periods of less length. Tree A, which has the shorter period, is larger and more vigorous than tree B. It is not possible to fix a quite definite point in the cycle, as leaf change is gradual, but the following dates indicate approximately comparable stages in successive periods.

	tree A	period	tree B	period
new leaves	11.12.1927		8.3.1928	
do.	11.9.1928	9 months	13.1.1929	10.2 months
do.	1.6.1929	8.7 „	20.11.1929	10.4 „
do.	1.3.1930	9 „	10.9.1930	9.6 „
do.	1.12.1930	9 „		

Cassia nodosa Ham.
Southern Asia.

A tree which is referred with some doubt to this species, growing in the Singapore Gardens, loses its leaves slowly from about November to March (much as *Terminalia subspathulata*) and produces new leaves about April. It bears a few flowers with the new leaves. but has never produced any fruits. It was planted about 1912. In each of the three years 1928 to 1930 the tree has begun to produce new leaves abundantly in early April. New leaves appear at first slowly on a few twigs a month or more before the general development of new foliage, so that it is impossible to give exact dates.

Cedrela toona Roxb.
India and Malaya.

A fine tall tree of this species has been observed over two complete leaf-periods. A neighbouring tree has been later in each year in the development of new leaves, but exact dates for this second tree have not been recorded. The tree gradually loses its leaves over a period of several months, and finally stands bare for about a month. New leaves usually begin to appear on the top of the tree, the tree is fully green after about a month, and flowers heavily after about two months. The approximate dates of appearance of new leaves on the tree observed have been:

	Interval
8.7.1928	
4.8.1929	12.9 months
30.7.1930	11.9 months

Couroupita guianensis Aubl. Cannon-ball tree.
Guiana.

This species is said to change its leaves three times a year in British Guiana (see Journ. Board Agr. Brit. Guiana vol. 12 p. 41). The only mature tree in the Singapore Gardens has been observed through three successive periods of about 6 months each. The leaf-fall is very rapid (usually complete in about a week), and new leaves appear at once. There are nearly always some flowers on the tree; I have not been able to associate definite periods of maximum flowering with definite phases of the leaf period. New leaves have developed on the following dates:

	Period
15.9.1929	
23.3.1930	6.3 months
16.9.1930	5.8 months
22.3.1931	6.2 months

Cratoxylon formosum (Jack) Dyer.

India to Indo-China, Malaysia to Moluccas.

This beautiful species appears to exist in two distinct varieties in the Singapore Gardens; the two forms differ in the size of all parts, and in some details of the phenomena of leaf change. The smaller variety is the more abundant, several trees of it occuring in the Gardens Jungle. This smaller form usually changes its leaves a branch at a time, whereas the larger one changes all the leaves at once; the new leaves on the smaller form are also much deeper in colour than those of the larger. In both forms, the new buds begin to open about the time that the last old leaves are falling, and the tree produces masses of small pink flowers which last for a few days while the leaves are just beginning to open. I give below records of the behaviour of two trees of the larger form, both in the Singapore Gardens, but distant from each other. Both are well grown trees.

	tree A	period	tree B	period
new leaves	1.9.1927		6.2.1928	
do.	10.6.1928	9.3 months	21.10.1928	8.5 months
do.	17.3.1929	9.2 „	30.6.1929	8.3 „
do.	23.2.1930	11.2 „	7.4.1930	9.2 „
do.	27.9.1930	7.2 „	12.1.1931	9.2 „

The leaf-fall was very slow during the last three months of the third period recorded for tree A. The weather at this time was rather unusually dry, which may have retarded the development of new leaves.

It is difficult to obtain comparable figures for successive periods of the smaller variety, on account of its habit of changing its leaves branch by branch. The following observations of dates of new leaves on first and last branches for each complete leaf change on one tree will give some idea of the behaviour of this variety.

	first branch	last branch	leaf-period first branch
new leaves	30.8.1927		
do.	12.5.1928	24.6.1928	8.4 months
do.	17.2.1929	5.5.1929	9.2
do.	13.10.1929	17.2.1930	7.9 „
do.	14.4.1930		6.0 „

Cratoxylon polyanthum Korth.

Burma to Indo-China, Malaysia to Philippines.

Two large trees of this species have been under observation. Like *C. formosum*, it is deciduous, but differs in producing its flowers after the leaves are fully grown. In

February 1930 the trees were bare for three weeks; no definite records of the bare periods were kept in former years. The two trees have changed their leaves almost simultaneously in the three years; the dates were as follows.

12.3.1928	1.3.1929	25.2.1930	23.2.1931
periods:	11.6 months	11.8 months	12 months

Cyrtophyllum peregrinum Bl. Tembusu.
Cambodia and Malaysia to Philippines.

This evergreen tree is largely used for ornamental purposes in Singapore. So far as I have been able to observe, it produces new leaves continuously throughout the year. It is interesting on account of the periodicity of its flowering. In the years 1928-1930 all the trees which I noticed in Singapore flowered heavily in the month of May, fruiting heavily in September, when they were visited nightly by large numbers of flying foxes. Most of the trees also had a smaller flowering in October and November, but this was not so general. Some trees flowered a little at other times, usually on odd branches.

This very marked regular and general flowering of an evergreen species is rather curious, when compared with the much less regular flowering of the durian, mangosteen and rambutan.

Durio zibethinus Murr. The Durian.
Malaysia.

This is one of the most important local fruit trees. In Singapore there appear to be two flowering seasons, March and September (approximately), but the amount of flowering is very uncertain. The March flowering is usually a heavy one, leading to the principal fruit crop about July; but sometimes this flowering almost fails (as in 1927 and 1928). The September flowering is usually a small one, leading to a small fruit crop about January; but it may be a heavy flowering, as in September 1927. I believe that the March flowering is connected with the usual fairly sudden change from the wet season of November-January to drier weather about February and March. If this change does not occur, there is little stimulus to the trees to flower; this was the case in 1927, when wet weather continued steadily until June and the July fruit crop failed. In such a case, the trees respond readily to the dry weather which often occurs in July-August, and this occurred in 1927, when there was a general flowering in September and a heavy fruit crop the following January. In 1928 the early part of the year was again rather wet, and I observed no durian trees flowering. Some trees in various places

flowered moderately about September 1928, and there was a small fruit crop in January 1929. January 1929, after the first six days, was fine and dry, though February was wet; the durian trees flowered heavily in March, and there was a good fruit crop in July. July was dry, but owing to the fruit crop then maturing few trees developed flower buds; a few did so however and there was a small fruit crop in January 1930. In 1930 there was again a good flowering about March, and a fruit crop in July. July and August were very dry, but the trees again had very few flowers in September. It is evident that a heavy crop of fruit once a year is as much as the trees are capable of producing; the crop appearing six months after a heavy crop is always a small one and may perhaps be borne by trees or branches which had no part, or little part, in the previous heavy crop.

Dyera laxiflora Hook. fil. Jelutong.
Malaya.

This tall forest tree is represented by several fine specimens in the Singapore Botanic Gardens. They are deciduous, usually losing all their old leaves before the new buds open. There are however some irregularities of behaviour, and all the trees do not always change their leaves simultaneously. Sometimes new leaf-buds open before the old leaves have fallen, and sometimes leaves are changed on only part of the tree at one time. In the latter respect, the same tree will behave differently on different occasions, as the records given below will show. Two trees have been under observation. One (A) is very tall, and has the trunk forked near the base. The other is smaller and of normal shape. Both stand in the open, away from the Jungle, and bear leafy branches almost to ground level. Flowers are usually (but not always) borne with the new leaves; the first flowers open about 10 days after the leaf buds begin to expand, and a fresh crop of flowers open every night for about a week, falling at dawn. The new leaf growth is completed in three to four weeks, and usually no more leaves are produced until after the next leaf-fall.

Tree A.
6.9.1927 new leaf buds opening on branches of main trunk.
16.9 to 22.10 new leaves appear on other branches.
17.3.1928 new leaf buds opening over almost the whole tree.
1.4.1928 other leaf buds opening.
14.6.1928 leaf buds opening all over tree.
11.9.1928 new leaf buds opening on part of tree.
6.4.1929 new leaf buds opening all over tree.

20.10.1929	do	do
25.5.1930	do	do
1.10.1930	do	do

The intervals between the principal leaf changes were accordingly as follows: 6.3, 2.9, 2.9, 6.8, 6.5, 7.2 and 4.2 months.

The fruits formed after the flowering of April 1929 began to dehisce about December 20th, thus taking nine months to ripen; they were grown to approximately full size in less than half that time.

Tree B.

17.3.1928 new leaf buds opening generally.
20.5.1928 new leaf buds on lower branches.
11.9.1928 new leaf buds opening generally.
14.4.1929 do do
21.7.1929 new leaf buds on lower branches.
3.11.1929 new leaf buds opening over most of tree, the old leaves not having fallen.
25.5.1930 new leaf buds opening generally.

The intervals between the above principal leaf-changes were 5.8, 7.1, 6.7, and 6.7 months.

Entada spiralis Ridley.
Malay Peninsula.

A massive liane of this species grows near the Director's house at the Singapore Gardens. It is deciduous, losing all its leaves and remaining bare for a few days before the new buds open. The leaves turn yellow and brown and are all fallen in about a week from the first sign of yellowing. Flowers appear with the new leaves. It is possible that they also occur occasionally at other times, as I observed fruits in April 1930 without having seen a leaf change previously. I have no record of a leaf change in 1930, but I think that one must have occurred. I was away from Singapore during the second half of the year. New leaves began to appear on the following dates:

	interval
10.5.1928	
3.2.1929	8.8 months
6.10.1929	8.1 months
25.2.1931	16.6 months

Eugenia grandis Wight. Jambu laut.
Malaya and Siam.

Very many trees of this species have been planted in Singapore by roadsides, especially in the rural areas, and their periodic gregarious flowering is a remarkable sight. When they flower heavily the trees are for a week covered with masses of white blossoms. There is a good deal of variation however in the heaviness of flowering on different occasions, and also from tree to tree; and occasionally odd

trees flower by themselves, though this is not a very frequent occurrence. At certain fairly definite periods the trees produce new leafy shoots which elongate rapidly, the flower buds being borne in the axils of the last few pairs of leaves on some of the shoots. The flowering therefore appears rather as an accompaniment of new leaf production than as a separate phenomenon as in many evergreen trees. Usually heavy flowering accompanies rather small leaf production, and the reverse. Leaf-fall is gradual throughout the year and does not appear to be affected to any considerable extent by the opening of the new buds; but in some cases towards the end of an interval of vegetation all the old leaves drop off and at the next opening of the buds a complete leaf change occurs. The fruits take about two months to ripen.

About 16 trees in Cluny and Dalvey Roads have been under observation for two years, and the earlier records of general flowering in Singapore were kept. Among the sixteen trees there was great irregularity in behaviour at different flowering periods and individual trees behaved differently from period to period. Thus one tree produced new leaves only without flowering for three consecutive periods from July 1929 to March 1930 and then flowered heavily twice in succession; another tree has flowered moderately at every period observed; a third tends to flower heavily always; a fourth tends to alternate light and heavy flowering.

The times of general flowering in the years 1927 to 1931 have been in March-April, July-August, and December-January. The intervals between times of flowering are thus 4, 5 and 3 months. There is some variation from year to year. The actual dates have been approximately:

second half December 1927
first half April 1928
first half July 1928
first half December 1928
end March—early April 1929
end July—early August 1929
end December 1929—early January 1930
end March—early April 1930
end July—early August 1930
second half January 1931.

Ficus glabella Bl.

South-eastern Asia.

A large tree, probably of this species, has been under observation since 1927. It has changed its leaves three times a year, but at irregular intervals. The leaves turn yellowish and fall rapidly; the tree is then bare for a few

days at most before the new leaf buds begin to expand. The crown of the tree is completely covered with new leaves in a fortnight from the time that new growth begins. The dates on which new leaf buds began to open were as follows:

dates	intervals
15.10.1927	
29.1.1928	3.5 months
3.6.1928	4.1 „
4.11.1928	5.0 „
3.2.1929	3.0 „
17.5.1929	3.5 „
20.10.1929	5.1 „
23.1.1930	3.1 „
8.6.1930	4.5 „
11.11.1930	5.2 „
10.2.1931	3.0 „

Ficus polysyce Ridley.

Malay Peninsula and Southern Siam.

This species is deciduous, and also cauliflorous, bearing usually a heavy crop of fruits all over the trunk and main branches. Five complete leaf periods have been observed, and also the development of fruits during the year 1929. The new leaf buds begin to open as soon as the tree is bare, or within a few days. The production of fruit buds appears to have no relation to the leaf-cycles. The time of development of the fruits, from the first growth of the buds to ripeness is rather more than six weeks. One crop of fruits succeeds another after a brief interval. In 1929 a new crop of fruit buds developed every two months. Some crops were heavier than others. The times of new leaf development were as follows:

date	interval
12.8.1928	
6.1.1929	4.8 months
14.7.1929	6.3 „
7.2.1930	6.7 „
5.8.1930	6.0 „
8.2.1931	6.1 „

Ficus religiosa L.

India.

This species is deciduous, with an annual leaf cycle, in India. It is commonly planted in Singapore, but does not grow very vigorously. It is subject to a leaf disease which

may cause premature defoliation. The trees stand bare only a very short time after leaf-fall; in many cases the new leaves begin to appear before the old ones are all gone. A rather young tree near the Botanic Gardens was observed through two leaf cycles. The dates of appearance of new leaves were approximately as follows:

date	interval
21.10.1928	
20.5.1929	7 months
15.1.1930	7.8 „

Garcinia mangostana L. The mangosteen.

Malaysia.

The flowering and fruiting of this species usually coincide approximately with those of the durian. The heavy fruit crops of the two species were synchronous during the period under review, except that the mangosteen crop of January 1928 was a small one. I noticed no mangosteen fruits at the times of the small durian crops of January 1929 and January 1930.

Grammatophyllum speciosum Bl.

Malaysia.

This large orchid is seasonal in its flowering in Singapore. The flowers are usually open about July-August or December-January. According to Ridley the former is the more usual season; he records heavy flowering in December 1906, there having been none in the previous July, and Burkill records flowering in January 1914 instead of July 1913. Almost all of the plants in the Gardens flowered in December 1927 to February 1928. No flowers were seen during the rest of 1928. In February 1929 I saw a flower brought from another part of Singapore. In August-September 1929 one of the plants in the Gardens bore two inflorescences only. In December 1929 and January 1930 Mr. Laycock's plants in Cavanagh Road bore many flowers; one plant in the Gardens had one inflorescence. Another plant in the Gardens flowered freely in January and February 1930. In July and August 1930 there was a general flowering of plants in the Gardens. The plant which flowered in August 1929 flowered again in January-February 1931 when no other plants were flowering. It appears that heavy flowering of this orchid usually coincides with heavy fruiting of the durian (see discussion under *Durio zibethinus*); this is also the case in Penang (usual season July-August) and in West Java (usual season December-January).

Heritiera elata Ridley.

Singapore.

A very tall tree of this species in the Singapore Gardens changes its leaves completely at long intervals. No further growth of new leaves has been observed between two successive complete changes but as the crown of the tree is very lofty it is possible that some new growth may have escaped observation.

Regular observation of the tree began in January 1928. No growth or other changes were noticed until on February 12th 1929 it was observed that leaves were falling and the tree flowering very copiously. The flowering was over by March 10th, and on March 17th it was noticed that new leaf buds were opening over most of the crown of the tree, the old leaves not having yet all fallen. The expanding new leaves were pale olive in colour. New growth continued and the remaining old leaves continued to fall until about the end of June.

No further changes were observed until February 1st 1931, nearly two years after the commencement of the previous leaf-fall, when a fresh leaf-fall was found to have begun. During the next fortnight many leaves fell, but there was no flowering. On February 19th new leaves were seen developing on many branches, and a month later the crown of the tree was fully covered with pale olive-brown young leaves.

Hevea braziliensis Muell. Arg. Para rubber.

Brazil.

Wright reports (p. 438) that at Peradeniya this species usually loses its leaves in February and March, nearly all trees bearing new leaves in March. Coster (1927, p. 98) states that in east Java the trees are usually bare for a few weeks at the beginning of the dry season, but that different individuals differ as to the time of change and length of leafless period. In west Java the irregularity is very great as to the time of change.

In Singapore also there is great irregularity. During any pronounced dry period many trees may be seen changing their leaves, but I have never seen a simultaneous change by all trees. Two large trees in the Singapore Gardens during the period 1927 to 1930 changed their time of complete leaf renewal from August to March; between complete leaf changes there were partial leaf changes (on some branches only). Possibly some partial changes were unrecorded. The behaviour of the trees was:

tree W

August 1927 complete renewal of leaves after bare stage.

August 1928 leaf change on greater part of tree, but not on some branches.

March-April 1929 leaf change on some branches only.

March 1930 complete renewal of leaves.

tree V

August 1928 complete renewal of leaves.

April 1929 partial renewal.

September 1929 partial renewal.

March 1930 complete renewal.

Two young trees, both budded, planted about 1924, in the Singapore Gardens, were also kept under observation. One of them never changed its leaves completely during the whole period of 3½ years; at intervals of from one to three months it produced a certain number of new leaf shoots, and lost a few leaves. The other tree changed its leaves as a whole three times, new leaf growth beginning approximately on 22 July 1928, 1 September 1929 and 22 September 1930. In May 1929 one small branch lost its leaves, flowered, and produced new leaves.

Hymenaea courbaril Linn.

S. America.

There are several fine trees of this species in the Singapore Gardens. One of the biggest, a tree considerably more than 100 feet in height, has been observed since 1927. Its behaviour in 1928 and 1928 was identical. In January and February the leaves gradually turned yellow and many fell; new leaves began to appear generally about the middle of February, before the old ones had all fallen; new bronzed leaves continued to develop until the end of March; flower buds appeared in May, the flowers opening towards the end of the month and continuing for about three weeks, the fruit ripening and falling towards the end of the year. In 1930 new leaves began to appear on some branches by January 12th, and the leaf change continued gradually through January and February; flowering began about the end of May as before. In 1931 a few new leaf buds began to develop during January, but over the greater part of the crown no new growth began until about February 20th, by which time a great part of the old foliage had fallen. Throughout the period of observation, no new leaf growth was seen after the growth of February and March was

completed. Another tree which is apparently of the same species but differs in having a very spreading instead of tall upright habit, behaves somewhat differently. This tree has flushes of new leaves, and then flowers, on various branches in turn throughout the year; the new leaves also are bright green and lack the bronzed colour of the young leaves of the tall tree. On two occasions however (in 1928 and 1931) this tree has had a general leaf fall and renewal of leaves at the same time as the tall tree; as regards the years 1929 and 1930 my records are not definite.

Jacaranda filicifolia Don.

S. America.

I have had three trees of this species under observation since 1927. Each has behaved rather differently from the others. One tree has been leafy on most of its branches throughout, never flowering as a whole at any time; from time to time a few branches have lost their leaves and then borne flowers. A second tree slowly lost almost all its leaves, and then flowered heavily, each year; and each year it has flowered somewhat earlier than the last. In 1928 its flowering (which lasts about 2 months) began about the middle of May, in 1929 at the end of April and in 1930 about the middle of April. The third tree flowered rather heavily in August 1927, July and August 1928, June and July 1929, June and July 1930. A fourth tree has also the habit of losing its leaves almost entirely before flowering; it flowered in July and August 1928 but I have no further records. On all these trees new leaf growth begins towards the end of the flowering period, but it is impossible to give definite dates as the development is very gradual.

Kigelia pinnata DC.

Tropical Africa.

There is a tree of this species in the Singapore Gardens which has changed its leaves in three successive years in the month of February. The old leaves turn brownish towards the end of the year, but there is little leaf-fall until about a fortnight before the change is due. Most of the leaves fall in a few days, and the new leaves grow very rapidly as soon as the tree is bare, or even before the old leaves are all fallen. Flower buds begin to develop about the same time as the leaf buds, some on the old wood and some on the new shoots. I have never seen fruit on this tree in Singapore, though a tree on the hill at Penang (2500 feet above sea) fruits heavily. The actual dates on which new leaves were observed developing on the Singapore tree were: 10.2.1929, 17.2.1930, 10.2.1931.

Koompassia malaccensis Maing. ex Benth.

Malay Peninsula and Sumatra.

An old tree of this species in the Singapore Gardens, 130 feet high, a relic of the forest which formerly covered the area, has been under observation since 1927. Its behaviour has been very regular, except that in 1928 it did not flower. The dates on which new leaves began to appear were as follows; 17.9.1927, 11.9.1928, 8.9.1929, 21.8.1930. The tree has thus a period of about 12 months. The old leaves turn brownish and fall rapidly, the new leaf buds opening as soon as the tree is bare. Flowers appear about six weeks later, and the fruits are ripe about three months after flowering.

Lagerstroemia speciosa Pers.

India to S. China, and southwards to tropical Australia.

Wright states (p. 441) that at Peradeniya the leaves of trees of this species usually fall in January and February; there is a leafless phase of from 4 to 32 days; the new leaves appear in March. Coster reports (1927, p. 114) that in East Java the trees may be bare for a time during the dry season, but that some trees produce new leaves before the old ones are all fallen; the trees flower shortly after the new leaves appear, about September. At Buitenzorg the behaviour of this species is irregular. At all times of the year there are trees with new leaves and flowers, and different branches of the same tree behave differently. The leaf-change however usually takes place in the drier months of July to September.

In Singapore the trees are very irregular, no two behaving quite alike. Two trees have been kept under observation since 1927. Tree A is a well grown tree in which the new leaves appear irregularly at first on the lower branches, sometimes before all the old leaves are gone from the top of the tree; it is not easy to fix an exact date for the beginning of new leaf production. Tree B is a younger tree of which the two halves behave differently, the northern (larger) half bearing new leaves one or two months later than the southern half. The records are as follows:

Tree A

new leaves	interval
3.9.1927	
27.5.1928	8.8 months
10.3.1929	9.4 „
17.11.1929	8.2 „
29.10.1930	11.4 „

Tree B

S. Side, new leaves	interval	N. Side, new leaves	interval
20.7.1927		20.8.1927	
12.5.1928	9.7 months	10.6.1928	9.7 months
10.3.1929	10.0 „	21.4.1929	10.4 „
17.11.1929	8.2 „	23.2.1920	10.1 „
1.9.1930	9.4 „	25.11.1930	9.1 „
7.5.1931	8.2 „		

Lecythis sp.

Tropical America.

A tree of an unknown species of Lecythis in the Singapore Gardens appears to change its leaves once a year; the period however is not quite constant, as the following dates show. New leaves appeared after a bare stage of a few days on 8.7.1928, 18.8.1929 and 8.8.1930.

Mangifera indica, Linn. The Mango.

India.

Coster (1923 p. 137) states that trees in East Java grow their new leaves in the dry season at various times. The new growth is completed in 2–3 weeks, after which no more occurs for a year. A few trees may change their leaves in the rainy season. The trees flower at various times between July and October, the flowering being unconnected with any leaf change.

Two old trees grow by the side of the lake in the Singapore Botanic Gardens. In 1928 and 1929 they changed their leaves together, the new leaves appearing approximately on July 1st 1928 and June 1st 1929, an interval of 11 months. In 1930 the northern tree produced its new leaves about March 2nd, after an interval of only 9 months; the southern tree however bore new leaves about May 5th, again at an interval of 11 months. In 1931 the southern tree renewed its leaves at the beginning of April, again after about 11 months; but the northern tree had not yet produced any new leaves at that date, 13 months having elapsed since its previous change. In all cases the new leaves develop before the old fall, the old falling rapidly while the new growth is taking place. The trees only once flowered heavily in the period under review, about February 3rd 1929. There was a sudden break of the wet season after the first week in January, the rest of that month being dry.

Nephelium lappaceum L. The rambutan.

Malaysia.

The flowering of the rambutan trees in Singapore seems to be more evenly divided between the two seasons

than is the case with the durian and mangosteen. In the period September 1927 to December 1930 the only season in which I noticed no flowers was March 1928. Coinciding with the heavy durian crops of January 1928, July 1929 and July 1930 were good crops of rambutans; in January 1931 there was a fairly good crop of rambutans though little or none of durians and mangosteens.

Parkia Roxburghii Don.

Assam through Malaysia to the Philippines.

This species is peculiar among the leguminous trees which I have observed in bearing its flowers towards the end of its leaf-period, the old leaves falling before the fruits are ripe. A very tall tree in the Singapore Gardens flowered each year from 1927 to 1930 in the month of October, the leaves beginning to turn brown and to fall about the same time. The tree was bare, with almost ripe fruit, about the beginning of February, and remained bare about two or three weeks before the new leaves began to develop. The actual dates of development of new leaves were: 27.2.1928, 27.2.1929, 17.2.1930, 19.2.1931. It is clear from these dates that this tree, like those of Koompassia and Hymenaea, is strictly annual in its habits. Two other trees, in different parts of Singapore, have been observed to synchronise fairly closely with the tree in the Gardens.

Peltophorum ferrugineum Benth.

From Tenasserim through Malaysia to Australia.

This tree is commonly used for ornamental purposes in Singapore, and there are several individuals in the Gardens. Two old trees growing close together, and two young trees in different parts of the Garden have been under observation. The young trees show a good deal of variation in behaviour, but the two old trees always go through their leaf changes together (sometimes one is a few days behind the other) and have changed their leaves at intervals of about six months. The trees develop their new leaves rapidly, and produce flower buds as soon as the new growth is completed; flowering takes place about two months from the time of first leaf development. After flowering (occasionally flowering does not occur, or occurs only to a small extent) the leaves gradually turn brown and fall while the fruits are ripening. New leaves begin to open within a week or so of the beginning of the bare period. The large trees (O) have never entirely missed flowering, but the tree E had no flowers during its one abnormally short leaf period (in 1929). On the other hand the young tree F bore a few flowers in its shortest period of 4.1 months; in other periods it had no flowers. An insect attack appeared to cause premature defoliation

of this tree on one occasion, and this may account for its greater irregularity. The dates of appearance of new leaves for these trees were as follows:

Two trees O	int. months	E	int. months	F	int. months
8.1.1928		8.10.1927		1.4.1928	
24.6.1928	5.5	17.6.1928	8.3	11.11.1928	7.3
3.2.1929	7.3	3.3.1929	8.5	14.4.1929	4.1
21.7.1929	5.6	18.8.1929	5.5	25.8.1929	4.4
30.1.1930	6.3	1.4.1930	7.4	15.1.1930	4.7
8.8.1930	6.2	15.1.1931	9.5	22.7.1930	6.2
4.2.1931	5.9			10.3.1931	7.5

Wright (p. 440) reports that at Peradeniya trees of this species lose their leaves irregularly twice a year, in December-January and June-July. Coster (1923, p. 133) states that in east Java the trees are very irregular. They change their leaves in the dry season, with or without a bare period; but many trees also change in the wet season, with a leafless phase. The principal flowering season is during the dry months July-October, but some trees may be found flowering at all times of the year.

Poinciana regia Boj. Flame of the forest.

Madagascar.

In east Java this species is bare for 2-3 months during the dry season, but sometimes not all the leaves are lost. New leaves develop at the end of September and in October (a few buds earlier) but the trees are only fully leafy when the new rains begin. The flowers appear with the first leaves, or before the leaves, and completely cover the tree. During much of the wet season new leaves and some flowers develop. (Coster, 1923, p. 131).

At Buitenzorg the trees behave as in East Java, but leaf-fall comes a little later and new leafing is irregular; all trees stand bare for one to several months. (Coster 1927, p. 86.)

In Singapore trees of this species may be found in flower at all times of the year. There is no definite season for flowering, but one has the impression that sometimes more trees are flowering than at others. I have observed the behaviour of a very fine mature tree in the Botanic Gardens from the middle of June 1928, when the tree was bare. The sequence of events was as follows:

1928 June 24 first new leaves opening
July 29 new leaves opening slowly, and some flowers
Sept. 5 tree covered with flowers, and many leaves
Oct. 28 flowering nearly over

1929 Jan. 20 some leaves falling
Mar. 10 nearly bare
Mar. 30 first new leaves opening
Apr. 28 many leaves opening, and some flowers
June 16 crown covered with leaves; moderate flowering
July 28 flowering over
Oct. 20 some leaves falling
Dec. 12 nearly bare; first new leaves opening
1930 Feb. 17 very full flowering
Nov. 11 new leaves opening.

The new leaves appear rather slowly at first, and make it difficult to fix a definite point in the leaf-cycle; but it is clear from the foregoing data that the tree passed through a complete period between June 24, 1928, and March 30, 1929 (rather more than nine months), and another period between March 30 and December 12, 1929 (rather less than nine months). The flowering in June 1929 was not so full as in September 1928 or February 1930. I suggest that possible the degree of flowering depends on the dryness of the weather during the preceding leaf-fall; but I have no definite evidence of this. The third period of eleven months is a curious change from the tree's previous behaviour.

Pterocarpus indicus Willd. Sena, Angsana.
Malaysia.

In east Java trees of this species have a short leafless phase in July. They flower with the new leaves, and leaf growth continues for some months. After the rainy season is over the trees gradually lose their leaves. Young trees change their leaves at the same time, but without a leafless phase. (See Coster 1923, p. 133). At Buitenzorg the trees are usually bare before the new leaves develop, but not always, and the leaf change is very irregular. (Coster 1927, p. 89).

In Penang there are several fine avenues of this species. The trees renew their leaves and flower during the dry weather in the early part of the year, though there is considerable difference of behaviour from tree to tree. In Singapore unfortunately a disease killed all the principal avenues of Pterocarpus trees about the years 1918-1920, and few really well grown trees remain. Seven trees, about half grown, by Cluny Road, have been observed by Mr. Corner from August 1929 onwards. In August 1929 the trees had still new leaves growing on some branches. In 1930 one tree began its leaf-change in February, changing its leaves first on the lower branches and then on higher ones, the highest being the last to change, about May. The various branches flowered about a month after the new leaves began to appear. The other six trees were about

a month later than the first in beginning their leaf change, and behaved in the same way. In 1931 the trees behaved approximately as in 1930, and all trees of this species observed in Singapore in March 1931 were at some stage of leaf change. It is probable therefore that trees of this species usually change their leaves in Singapore at intervals of 12 months.

Sindora Wallichii Benth.

Malay Peninsula.

Two well grown trees of this species, growing side by side in the Botanic Gardens, have been under observation since 1928. One tree has renewed its leaves completely three times in the month of February; on the first occasion (1929) it lost all the old leaves before the new buds began their growth, but in 1930 and 1931 the new leaf growth began before the old leaves had fallen in any considerable quantity. The other tree has had two unequal periods, of 14 and 17.3 months. Both trees produce flowers as soon as the new leaf growth is complete, and fruit freely. Also both trees subsequently produce a few new leafy shoots on some branches from time to time, but no general production of new leaves except at the time of a complete leaf change. The dates of production of new leaves have been:

tree A	interval	tree B	interval
8.7.1928		10.2.1929	
8.9.1929	14 months	20.2.1930	12.3 months
18.2.1931	17.3 „	22.2.1931	12.1 „

Sterculia carthaginis Cav.

Tropical America.

A well grown tree of this species in the Singapore Gardens has been curiously irregular in its behaviour. When a general leaf-fall takes place, the procedure is as follows. The old leaves turn brown and fall, at first a few here and there, and finally the whole very rapidly; the leaf-fall takes from two to four weeks to complete. The new leaf buds begin to expand a few days before the fall is complete. The new growth is complete in about a fortnight. Flowers are borne with the new leaves. On various occasions however partial leaf change (on a few branches only) and flowering has taken place. The periods between general leaf changes were two short ones followed by two long ones. Dates of new leaf development were:

	interval
11.12.1927	
22.7.1928	7.4 months
10.3.1929	7.6 „
17.2.1930	11.2 „
21.2.1931	12.1 „

Flowering without leaf-change occurred in September 1927 and partial leaf change with flowering in December 1929 and September-October 1930.

Sterculia macrophylla Vent.
Malaysia.

Two young trees (aged about 15 years) in different parts of the Singapore Gardens have been observed. Their leaf-periods have been rather irregular. New leaf buds opened on the following dates, simultaneously with the fall of the old leaves:

tree C	interval	tree Z	interval
7.9.1927		16.9.1927	
5.8.1928	10.9 months	12.8.1928	10.9 months
1.6.1929	9.9 „	1.6.1929	9.7 „
20.6.1930	12.6 „	14.4.1930	10.4 „
2.2.1931	7.4 „	5.4.1931	11.7 „

Tamarindus indica Linn. The Tamarind.
Pantropic.

This species is slow in growth in Singapore and does not attain the large dimensions of the trees which form such fine avenues in the eastern part of Java. In east Java the trees change their leaves once a year, towards the end of the dry season, and are rarely leafless. At Buitenzorg the leaf change is irregular; the time of year is not fixed and there is not always a year between changes. An old tree changed its leaves in August 1923, January and September 1924 (Coster, 1927, p. 78). In Singapore I have observed a tree in the Botanic Gardens through two changes. The new leaves began to grow while the old leaves were falling, so that the tree was never quite bare. In 1930 and 1931 the leaves turned brownish and began to fall in January and February; in 1930 I first observed new leaves growing generally on March 23rd, and in 1931 on March 15th. In 1931 I observed several other trees in Singapore changing their leaves in the months of February and March. A young tree in the Gardens, planted in 1925, lost all its leaves and stood bare for a few days, the new buds opening about February 15th. It appears likely that most tamarind trees in Singapore change their leaves at about this season; but several more years observation is necessary to confirm this.

Terminalia catappa L. Ketapang.
S. Asia.

Wright reports (p. 428) that at Peradeniya trees of this species change their leaves twice a year in February-March and August-September. Coster (1923, p. 144)

states that in East Java the trees change their leaves twice a year, at about the same times as in Ceylon. Irvine (Plants of the Gold Coast, p. 408) reports that in the Gold Coast the trees usually change their leaves twice a year, or sometimes three times.

In Singapore I have kept exact records of one tree during six leaf-periods. This tree has changed its leaves at six month intervals, in January-February and July-August. My impression is that most of the other trees of this species in Singapore behave in a similar manner, but I have not enough records to be certain of this. The dates of development of new leaves for the observed tree have been:

8.1.1928	
8.7.1928	6.0 months
3.2.1929	6.8 „
11.8.1929	6.3 „
9.2.1930	5.9 „
8.8.1930	6.0 „
6.2.1931	5.9 „

Terminalia subspathulata King.
Singapore.

A fine tree of this species occupies a prominent position in the Singapore Botanic Gardens. It has a leaf period of about a year, but is not so constant in its behaviour as some other species. It begins to lose its leaves about October and continues slowly through the wet season and more rapidly in February and March. The new leaves appear about the same time as the last old leaves fall. The tree flowered very little in 1928 and 1929; in 1930 it flowered heavily about six weeks after the new leaves began to appear. The dates of new leaf production have been: 19.4.1928, 17.3.1929, 16.3.1930, 31.3.1931.

SUMMARY.

1. An account is given of the behaviour as regards leaf change of a number of deciduous trees in the very uniform climate of Singapore, and also of the flowering of a few species of evergreen trees. Some climatic data are given.

2. Trees of a number of deciduous species change their leaves annually, usually at the change of season about February; a few change their leaves in August.

3. Trees of four species have been observed to change their leaves twice a year, usually in February and August.

4. Trees of a number of other species each change their leaves at approximately constant intervals not of six or twelve months and almost independently of climatic conditions; there is variation from tree to tree even in the same species.

5. Trees of a few species have shown very irregular periods. In particular, trees of *Hevea braziliensis* are very uncertain in their behaviour.

6. The idea of senescence of leaves of deciduous trees is suggested as an explanation of the approximate constancy of period of deciduous trees in a relatively uniform climate; but even small climatic changes probably have some influence, the susceptibility to such changes varying with different tree species. The periodicity of deciduous trees is a result of the interaction of internal and external factors which differ slightly with every individual.

7. Some evidence of the dependence of fruit trees and other evergreen trees on dry seasons for flowering is given; and an account of the periodic flowering of certain species.

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ASPIDIUM MAINGAYI (Baker) Holttum, comb. nov.

There is a terrestrial Aspidium which is not uncommon in the natural forest remaining on Singapore Island, which has received at different times four specific names. It has also been confused with *Aspidium vastum* Bl., on account of its winged rachis (Beddome, Handbook, Suppl. p. 85). The synonymy is as follows:—

Polypodium heterosorum Baker, Syn. Fil. 2nd. Ed. p. 506 (1874)

Gymnogramme Maingayi Baker, Syn. Fil. 2nd Ed. p. 517 (1874)

Dictyopteris heterosora Beddome, F.B.I. Suppl. 20 (1876)

Selliguea Maingayi Bedd. F.B.I. Suppl. 24 (1876)

Phegopteris subdecurrens Luerrs, Bot. Centralbl. 11, 30 (1882)

Aspidium subdecurrens C.Chr., Ind. Fil. p. 94 (1905)

Polypodium Maingayi Diels, Nat. Pfl. 1, 4, p. 318 (1899)

Hemionitis Maingayi Ridley, Journ. Malayan Branch R. Asiatic Soc. p. 106 (1926)

Campylogramme Trollii Goebel, Flora, N.F. 25, p. 282 (1931).

The name *heterosorum* in the genus Aspidium is already occupied by a species on p. 504 of the Synopsis Filicum; the next name in order of priority is therefore *Maingayi*. I have seen at Kew the type specimens concerned of Baker and Ridley; at Singapore are specimens which are declared by Dr. Carl Christensen to be identical with the type of *Phegopteris subdecurrens* (see this Bulletin vol. IV p. 393). From the photographs of *Campylogramme Trollii* I have no doubt that it also is to be referred to the same species.

Aspidium Bryanti Copeland from the Philippines is evidently closely allied.

Aspidium Maingayi is a terrestrial fern of shady forests, like most other malayan species of the genus. The lobes of fertile fronds are distinctly narrower than those of sterile fronds, and the fertile fronds usually stand erect in the centre of the plant, as in most terrestrial forest ferns. The production of fertile fronds is apparently a seasonal phenomenon, dependent on dry weather. The species is very variable, some forms being similar in habit to *Aspidium vastum* Bl. In the Malay Peninsula *A. vastum* does not appear to be common, whereas in the south at least and in some parts of Pahang *A. Maingayi* is locally abundant. Gœbel's *Campylogramme Trollii* was found on Pulau

Berhala, off the east coast of Sumatra; the lowland fern floras of Sumatra and the Peninsula are very similar. I have specimens of *A. Maingayi* from as far north as Penang, and eastwards from the Anamba Islands.

As regards form of the leaves, *A. Maingayi* is very variable, even among plants growing near together, and among fronds growing on the same plant. In the Singapore Botanic Gardens Jungle and the neighbouring aroid rockery are a number of plants growing spontaneously. Where a plant develops in a rather exposed position it grows only to a small size, with leaves having at most two pairs of lateral lobes, and will at this size produce fertile fronds. In more favourable shady places and in good soil the plants grow very large, the fronds with their stipes exceeding 1.20 metre in length, and bearing 5 or 6 pairs of lateral lobes or pinnæ, the lowest one or two of these being lobed again on the lower side and sometimes also on the upper side. The uppermost pair of lobes are always confluent with the apex of the frond, and their lamina is decurrent on the rachis, forming a wing. The extent of this wing is very variable. In the Singapore Gardens may be found fronds with the wing extending to the second pair of lateral lobes (or pinnæ) to the third, fourth or even fifth pair; and on some fronds (especially sterile fronds) the wing may extend half way or more down the stipe. The tendency in the gardens plants appears to be for later (and usually therefore larger) fronds to have a shorter wing than earlier fronds on the same plant; but some plants have more tendency than others to the shortening of the wing. On one small plant I found an earlier frond (fig 8, p. 231) with a wing nearly to the base of the stipe and a later frond (fig 7, p. 231) with the wing only just below the lowest pinnæ. At Bukit Timah, Singapore, are more plants, and among a group of these I could find none with a wing extending more than a few centimetres below the lowest pinnæ. Gœbel's illustration shows two fronds, one sterile (apparently the earlier one) with a wing nearly to the base, and a second fertile one with a wing not extending so far down the stipe. Gœbel's plant also, probably owing to pot culture and a rather strong light (compared with the light found in shady forest), has produced a fertile frond prematurely. From Gunong Tampin, and elsewhere in the neighbourhood of Malacca are specimens of fertile fronds with 3 or 4 pairs of lobes and a wing almost to the base of the stipe. There are also similar specimens from Klang Gates in Selangor, one from Temerloh, Pahang, and one collected by Bishop Hose at Penang. I have lately seen a large number of plants in Pahang, all with the wing extending down the greater part of the stipe.

On the other hand, a specimen from Perak (Kunstler 2289) has a rachis for the most part unwinged. Baker's *Gynmogramme Maingayi*, was based on specimens collected by Maingay and Pinwill, with rachis winged only towards the apex. His *Polypodium heterosorum* was based on a specimen of Griffith's, from Malacca, with the rachis and stipe broadly winged; as Beddome pointed out, this type is very like *Aspidium vastum* Bl., and in his Supplement (p. 85) Beddome definitely unites the two. In fact, there is little to distinguish the two vegetatively; *A. vastum* has a broader wing and usually narrower segments with more parallel sides. Both have similar long narrow scales on the stipes. The one definite distinction is in the sori. The sori of *A. vastum* are always round and indusiate. The sori of *A. Maingayi* are not indusiate and tend to spread along the veins. Gœbel's photograph (p. 285) shows this admirably. In different specimens there is variation as to the extent of the spreading. In nearly all there is a tendency to spread in lines close to and parallel with the lateral veins of the pinnæ, and in some this is very marked. There is also a tendency to produce lines close to and parallel with the midribs of the pinnæ. The intermediate sori unite in various directions.

The other local non-indusiate species of Aspidium, *A. Barberi* (Hk.) C.Chr. and *A. irregulare* (Pr.) C.Chr., also show in most cases some spreading of their sori along the small veins, though not to the same extent as in *A. Maingayi*. It is clear however that apart from the soral question *A. Maingayi* is much more nearly related to *A. vastum* than to either of the non-indusiate species mentioned, or to many indusiate species of the genus. I consider therefore that *A. Maingayi* should be retained within the genus Aspidium.

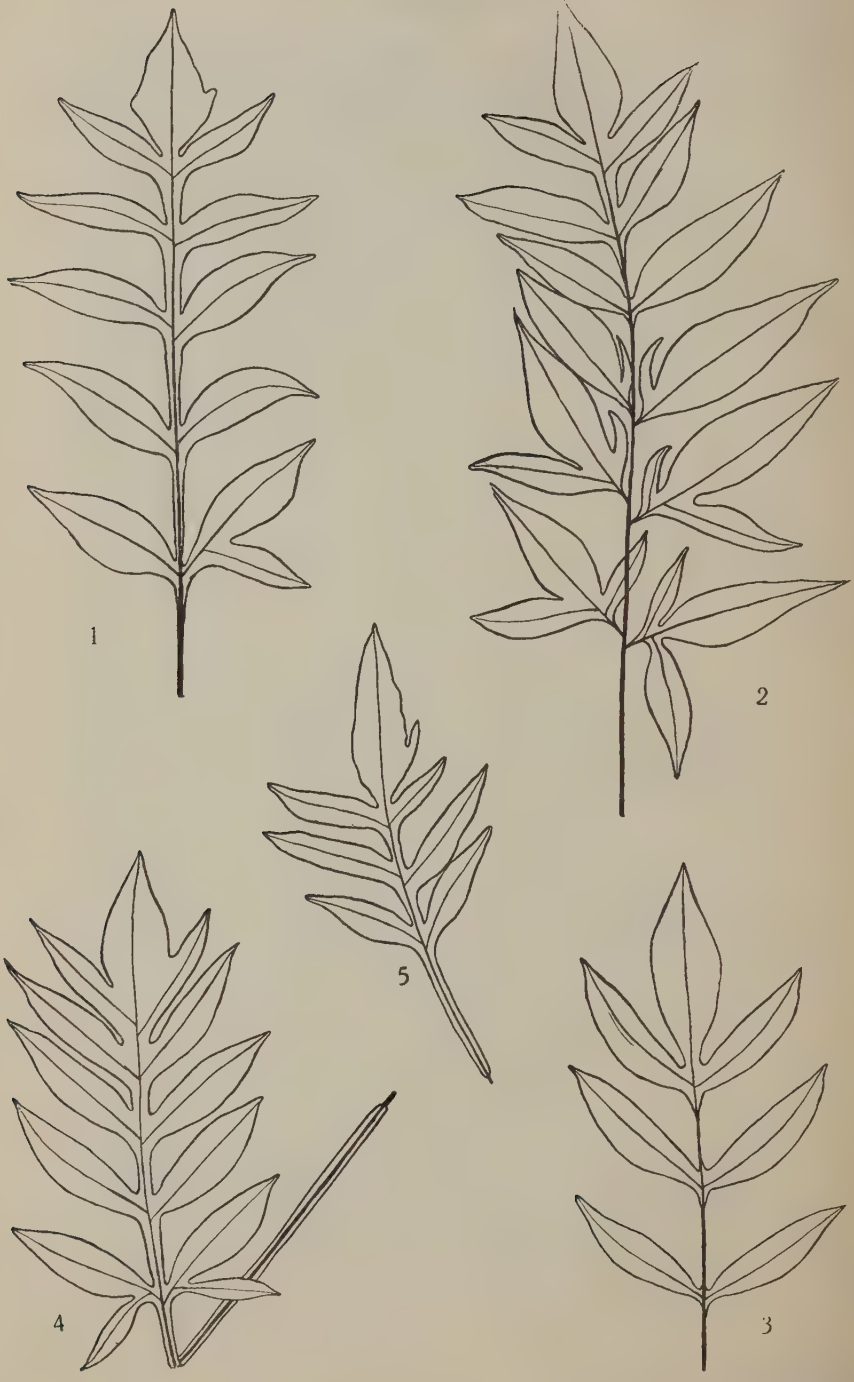
The spreading of the sori along the veins in these non-indusiate species of Aspidium is comparable with the spreading and confluence of the sori which is occasional in *Dryopteris urophylla* (Wall) C.Chr. (in which I have never been able to detect an indusium) and frequent in the allied species,, formerly referred to Meniscium, *D. cuspidata* (Bl.) Chr., *D. salicifolia* (Wall.) C.Chr., etc.

R. E. HOLTTUM.

Figs. 1—5, fertile fronds: 1—3, from Botanic Gardens, Singapore; 4, from Klang Gates, Selangor; 5, from Penang. The stipes of Nos. 1—3 are cut short.

Figs. 6—9, sterile fronds: all from Botanic Gardens, Singapore. The stipe of No. 6 only is cut short.

All figures ⅛ natural size.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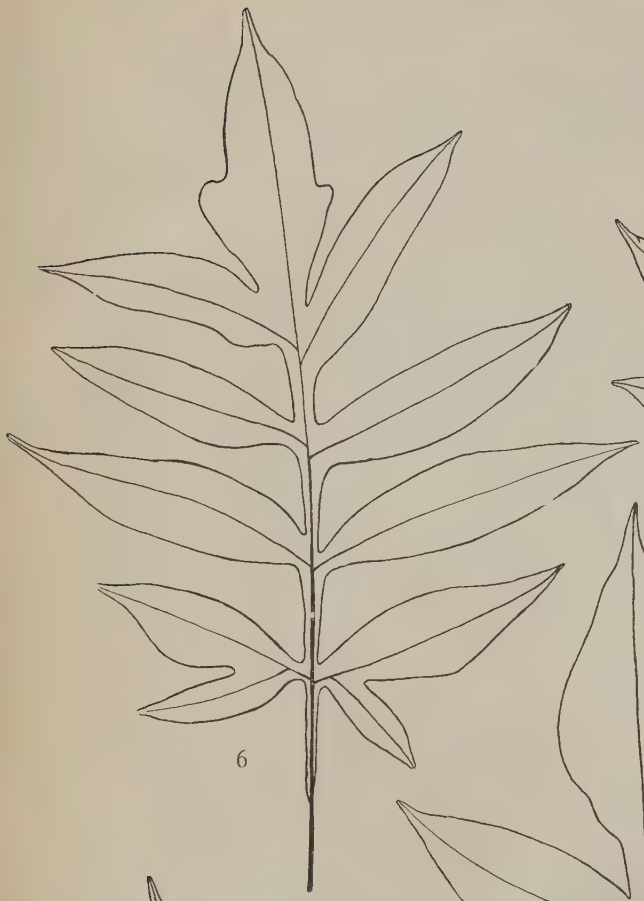

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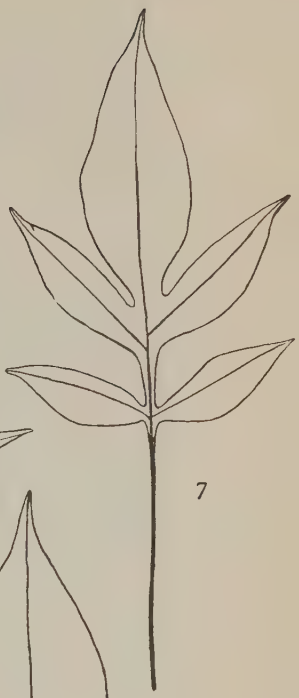

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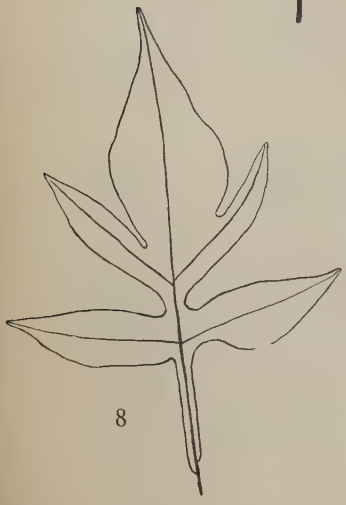

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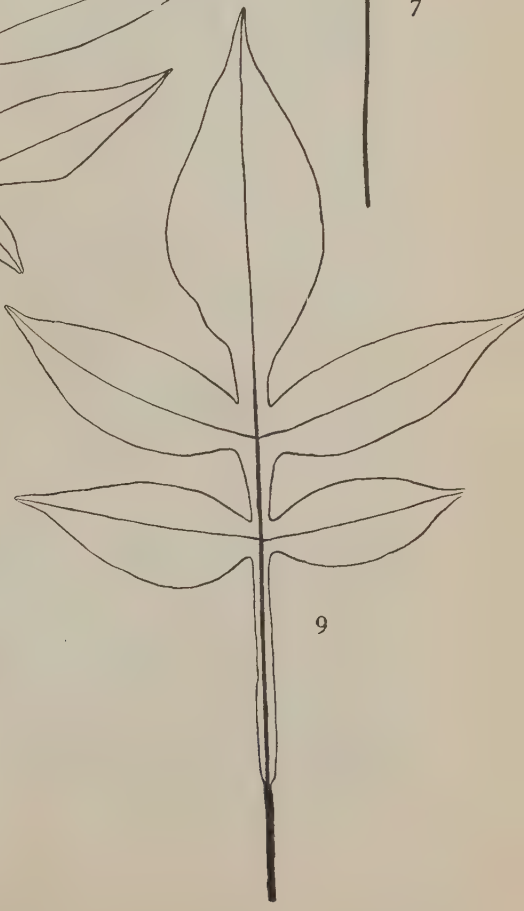

9

AN ENUMERATION OF THE SPECIES OF PARAMIGNYA, ATALANTIA AND CITRUS, FOUND IN MALAYA.

By I. H. Burkill, M.A., F.L.S.

At the present time botanists are unable to agree upon a scheme of classification for the genera of the Aurantieae or Citratae on account of insufficient information regarding most of the species; and very divergent views have been put forward. Swingle, for instance wishes to insert between the genera long recognised, " microgenera " with a narrowness which offends my conception of what a genus is: Guillaumin, on the other hand, has proposed the union of *Paramignya* and *Atalantia.* I propose here to add a little information to the common stock; to accept certain of Swingle's genera as subgenera; and to define afresh *Paramignya* and *Atalantia.* by the aid of their fruits. The type-species of *Atalantia* is *A. spinosa,* Koorders, though the generic name dates from a paper published by Correa in 1805. The type-species of *Paramignya* is *P. monophylla,* Wight, in 1838.

At first, that is to say by Wight, *Paramignya* was distinguished from *Atalantia* by the position of the two ovules,—one higher than the other in the first case, both at a level in the second,—and by the disunion of the filaments in the first and their union in the second.

When with the addition of further species to each genus, these characters seemed to break down, botanists put forward as an alternative the condition of the disc,—a simple gynophore in the first, a ring or cup in the second, and added that the anthers in the first show a somewhat greater elongation than in the second.

Then Guillaumin (in Lecompte, Not. Syst., 1, 1910, p. 175) pointed out that when a sufficient series of species is reviewed, the gradation from the one condition to the other makes it impossible to draw a line between the two genera. He characterised his combined genus *Atalantia* by, *inter alia,* the possession of fruits containing pulp-cells such as the oranges have. But had his material been more ample, he would have found no pulp-cells in several of his species including that upon which Wight founded the genus *Paramignya;* and he might have observed in the Malayan species which are without pulp-cells, bulkier seeds than in the others.

I propose to keep the name *Paramignya* for the species which are without pulp-cells, and *Atalantia* for those with pulp-cells. *Atalantia* thus lies next to *Citrus;* and *Paramignya* shares with some other genera more remote from *Citrus,* the character of pouring into its loculi from glands in the walls a small amount of a volatile oil.

Pulp-cells probably originated as water-storage tissue for the use of the growing ovules. A second stage in their evolution was entered on at once, for, pari passu, they commenced to store food-substances also. Man then selected the *Citrus* fruits with most stored substance, especially sugars. In this way the best of the newer species were created as cultigens which are placed towards and at the end of the enumeration which I give.

The pulp-cells of some of the species contain volatile oil. Its origin and function there need study, in which it must be remembered that the aromatic oils undergo change in *Citrus* fruits during ripening. Botanists who are able to examine the fruits of *Paramigyna* and *Atalantia* in life should seize any opportunity of studying them.

A. *STAMENS 6—10: ovules 1 or 2 in each loculus.*

B. *PULP-CELLS absent, a sticky secretion taking their place* ..... *PARAMIGNYA.*

The smallest flowered of the series is a species which bears the name *Atalantia trimera,* Oliv. It has three sepals and three petals; six stamens and fruit characteristic of *Paramignya.* It should bear the name *P. trimera.*

Atalantia missionis, Oliv., which should be known as *P. missionis,* is tetramerous. Swingle has made a genus, *Pamburus,* for it (Journ. Wash. Acad. Sci. 6, 1916, p. 336). To be pentamerous is the most usual condition.

1. **Paramignya cuspidata,** *Burkill; Atalantia cuspidata,* Ridley in Journ. Roy. As. Soc. Straits Branch, 82, 1920, p. 174, and Flor. Mal. Penins. 1, 1922, p. 357. This is a sprawling shrub known only from the west coast of the Malay Peninsula where it has been found in the Dindings (with flowers in February, *Ridley* 8391. and with fruit in March, *Ridley* 7944!) and near Malacca (Sungai Udang, with fruit in November, *Ridley and Goodenough* 1607!). Upon the last-quoted sheet it is called "limau pagar" or hedge-lime. The stamens are free and the ovary is carried on a columnar gynophore. The large seeds are surrounded by a sticky substance, which in the dried specimens smells like varnish.

2. **Paramignya** sp. An undescribed species found in the island of Penang (near the waterfall, with fruit in January, *Curtis* 2207!, and on Penang Hill, just after the fall of the flowers, in December, *Ridley* 7042!). It has subellipsoid fruits bluntly pointed at either end, a single seed at maturity, and a substance in the loculus smelling in the dried state like wood-tar. The possibility of it being *Amyris simplicifolia,* Roxb. is to be remembered.

Paramignya scandens, Craib: *Citrus scandens,* Griff.: *Paramignya griffithii,* Hook. fil., Flora Brit. Ind. 1, 1872, p. 510, excluding the Malacca specimen. This species was found by Griffith in Burma at the Serpentine Mines and described by him. It is now known to occur from the Eastern Himalaya and southern China into Siam and the Philippine islands: but it does not reach British Malaya.

The specimens quoted in the Gardens Bulletin 6, 1930, p. 181, among Malayan medicinal plants from Grik and Kuala Kangsar in Perak, and from Manchis in Pahang, seem to belong to this species.

3. **Paramignya ridleyi,** Burkill: *P. griffithii,* Hook. fil. in loc. cit., only as regards the Malacca specimen: Ridley, Flora Mal. Penins. 1, 1922, p. 356. This species has much longer pedicels than *P. scandens* and is abundantly distinct. It was collected in Malacca by Griffith, and by Hullett in Singapore. The backs of the leaves are less hairy than those of *P. scandens.*

4. **Paramignya lobata,** Burkill: *Atalantia hispida,* Ridley, Flora Mal. Penins. 1, 1922, p. 357, not of Pierre ex. Guillaumin: *A. monophylla,* Ridley in Journ. Roy. As. Soc. Straits Branch, 26, 1894, p. 26, not of DC. This curious plant with lobed fruits, has been collected twice, on both occasions near river-mouths. On the first occasion it was obtained in Johore (near Batu Pahat with fruits in November, *Lake and Kelsall!*) and upon the second in Kelantan (on the coast at Tumpat, near Kota Bahru, in fruit in February, Ridley!). Moreover a sterile twig collected in Negri Sembilan (no precise locality, *Alvins!*) may be it. The fruit is described as red. It has relatively large seeds, and the thin fruit-wall is extended by each seed which matures, into a lobe, up to the number of five.

5. **Paramignya angulata,** Burkill: *Citrus angulata,* Willd.: *Gonocitrus angulata,* Kurz: *Merope angulata,* Swingle in Journ. Wash. Acad. Sci. 5, 1915, p. 423; *Paramignya longispina,* Hook. fil.: Ridley, Flora Mal. Penins. 1, 1922, p. 356. This seems to be a coastal bush: at any rate it was found by Rumpf upon the coast of

Amboyna and has been found near the coast of Java, and in Singapore island seems to occur close behind the mangroves. Kurz mentions it in a paper upon Burmese plants, but does not say precisely that he had obtained it in Burma. It has very long thorns. The Singapore localities are:—Kĕranji, with fruit in February, Goodenough! Sungai Jurong, with fruit and flowers, but undated, *Ridley* 8062 !, and Kim Seng road upon the edge of Singapore town, with fruit, but also undated, *Ridley!* As a Malay name "limau lelang" is recorded, given doubtless in reference to a hawk's talons, the long spines being likened to them.

BB. *PULP-CELLS in the loculi: seeds smaller..... ATALANTIA.*

6. **Atalantia spinosa,** Koorders: *Sclerostylis spinosa,* Blume: *Atalantia monophylla,* DC.: Ridley, Flora Mal. Penins. 1, 1922, p. 356. This is a very widespread bush of India, which passes southwards through Burma and Siam, and into Malaysia in a permissive way, not being able to exist except in peculiarly favourable localities. It enters British Malaya at the north and passes southwards along the coasts to Penang: then it is in Pulau Tioman, in St. Barbe island, Banka and in Java. The following specimens from Lower Siam and Malaya have been seen. **Siam.** Prachuap, in fruit in September, *Put* 246! 288! and 289! Bangson, in fruit in May, *Mohamed Haniff and Mohamed Nur* 4022! Champawn, in flower in January, *Kerr* 12881! Kaw Tao, in flower in April, *Kerr!* Kaw Samui, in flower in November, *Put* 1275! Islet near Pulau Panji, in flower in November, *Mohamed Haniff and Mohamed Nur* 4063! Pulau Mohia, in flower in February, *Hamid* 2955! Kaw Sun Tun, in flower in January, Annandale! Pulau Tengeh, in fruit in April, *Ridley!* Terutao, in fruit in August. *Curtis* 1671! Telok Apau in Terutao, in flower in November, *Mohamed Haniff and Mohamed Nur* 7497! **Perlis,** at Chupeng, in fruit in March, *Ridley* 15039! **Kedah,** Langkawi islands, in fruit in June, *Curtis!* Pulau Songsong, in fruit in June, *Ridley!* and in fruit in May, *Mohamed Haniff* 12585! **Penang,** without precise locality, *Cantley's collector* 2562! Telok Bahang, Saleh! Pulau Butong, on the west of Penang island, Curtis 467! **Pahang.** On Pulau Tioman at Tanjong Layer, in fruit in May, Henderson! and at Telok Paya, also in fruit in May, Henderson 18409!

There is confused history in the nomenclature of this species. The adjective "monophylla" was used by Linnaeus in 1771 (Mantissa, p. 237) for an allied plant of Ceylon as *Limonia monophylla*: and in 1795 Roxburgh

figured our plant from the eastern side of India (Coromandel plants, p. 60 and plate 83) thinking it to be the same. Correa in 1806 (Ann. Mus. Hist. Nat. Paris, 6, p. 383) created the genus *Atalantia*, for Roxburgh's plant, but did not actually make the combination *A. monophylla:* this was reserved for DeCandolle in 1824 (Prodromus 1, p. 536). But obviously the Ceylon plant has a right to the name against our plant, and another must be substituted.

In 1825 Blume (Bijdragen tot de Flora van Ned.-Indie, 1, p. 134) described our plant as *Sclerostylis spinosa*. Much later Sir Joseph Hooker reduced *Sclerostylis* to *Atalantia* but did not make the combination *A. spinosa:* this was done by Koorders (Excursionfl. v. Java, 1912, 2, p. 427), who ascribed it to Hooker. However there is a possibility that the use of the adjective "spinosa" should be traced yet further back than Blume's paper in 1825, namely to Willdenow's *Species Plantarum* in 1800, where *Trichilia spinosa* is founded upon a specimen which I have not seen, with a reference to that part of Hellenius' *Turraea virens* which is his figure 1 and not his figure 2 (Kongl. Vetensk. Acad. Handl. Stockholm, 1788, plate 10).

7. **Atalantia kwangtungensis,** Merrill: *A. ?roxburghiana,* Hooker fil., Flora Brit. Ind. 1, 1872, p. 513: *A. roxburghiana,* Ridley, Flora Mal. Penins. 1, 1922, p. 357: Tanaka in Journ. Bot. 1930, p. 232, under *A. simplicifolia.*

A sprawling bush, very similar to the last, but a little larger; and in the Malay Peninsula, upon its southern border, as well as in Sumatra; moreover, Tanaka says that it occurs northwards in Annam and southern China. If Tanaka is right in identifying it with *A. kwangtungensis,* Merrill (the writer has been unable to verify this, but accepts his statement), it is by this name that it must be called; for the binomial *A. roxburghiana* which he uses unquestionably belongs to *A. simplicifolia.*

The localities in Malaya are:—Kedah, on Bukit Lanjut near Gunong Bintang, with young fruit in April, *Mohamed Haniff* 21029! Perak, in Upper Perak without precise locality, in fruit in July, *Wray* 3743! Gopeng District, on the top of limestone hills, with fruit in July, August and September, *Kunstler* 4557! 4724! and 8192! Malacca, *Griffith* 537!

8. **Atalantia simplicifolia,** Tanaka in Journ. Bot. 1930, p. 232: *Amyris simplicifolia,* Roxburgh, Flora Indica 2, 1832, p. 244: *Sclerostylis roxburghii,* Wight, Icones 1, 1838, plate 72: *Atalantia roxburghii,* Oliver in Journ. Linn. Soc. Lond. Bot, 5, second suppl., 1861, p. 25: *A.*

roxburghiana, Hooker fil., Flora Brit. Ind. 1. 1872, p. 513, excluding Griffith's plant which, however, was added with a query: *A. caudata,* Hooker fil., in the same place.

Roxburgh's species is recorded as a plant cultivated in the Honourable East India Company's Botanic Garden, near Calcutta, which had been obtained from Penang. A drawing of it exists at Kew, and a botanical specimen in the British Museum of Natural History. The drawing fails to represent the specimen exactly, chiefly in its broader leaves. The description might fit either, and is very brief. A closely corresponding specimen is preserved at Kew, labelled "Sclerostylis ?, Bengal" to which is added as a correction "Hort. Bot. Calc."

Wight published Roxburgh's drawing; and his name was not applied to anything but the drawing. Oliver recognised the specimen in the British Museum and possibly also that at Kew as identical with specimens which Hooker had collected at Cherra Punji in the Khasia Hills, and called both *Atalantia roxburghii.* Hooker, eleven years later, swayed by the drawing, dissented from Oliver's conclusion, called the Khasia Hills plant, *Atalantia caudata,* and with some doubt united to Roxburgh's species a specimen collected by Griffith in Malacca. He based his description upon the drawing, adding the shape of the fruit from Griffith's plant, declaring the source.

It is necessary to retreat from Hooker's position to Oliver's, but to adopt Roxburgh's specific name, as Tanaka has done.

Unfortunately the species has not been found again in Penang: nor are fruiting specimens available from any locality, so that it is possible for it to prove a *Paramigyna,* but the gynophore is cupular.

The only Malayan locality is Penang, and this on Roxburgh's authority.

AA. *STAMENS 10, free; the ovules numerous; (compound leaves).....CITRUS § PSEUDAEGLE.* In this place comes the curious bush, *Citrus trifoliata,* Linn. Some botanists have inserted it into the genus *Aegle:* the genus *Pseudaegle* was made for it; and Swingle has resuscitated Rafinesque's genus *Poncirus* for it (in Bailey's Stand. Cyclop. Hort., 1916, p. 2751). It is placed in a section, *Pseudaegle,* of *Citrus,* in Engler's *Pflanzenfamilien.*

It grows in more temperate climates than most species of *Citrus,* and can serve as a stock upon which they may be grafted. Moreover it hybridises with them.

9. **Citrus malaccensis,** Ridley, Flora Mal. Penins. 1, 1922, p. 359. The characters of this extremely interesting plant have not been brought into adequate prominence. It was collected in the year 1893 twice in the interior of the Territory of **Malacca,** and is represented in the herbarium of the Botanic Gardens, Singapore, by a sheet of each gathering. Derry obtained it with flowers in January, and Goodenough with fruit in July. Derry's locality is given as Bukit Sedanan; Goodenough's as Nyalas: these places are 6—8 miles apart. Upon the two sheets there are ten leaves; and upon each sheet one is compounded by having a single lateral leaflet. Other leaves have a scar at the apex of the narrowly winged petiole and therefore count as compound: others have no scar, and obviously are simple. Trifoliate leaves do not exist; but it would be curious if they are never produced. There is a conspicuous joint between the petiole and the leaf-blade or blades. The flower suggests that of *Merrillia caloxylon,* Swingle. The sepals are in shape as those of *Atalantia* and have large glands. The petals are nearly spathulate, and with glands in the broadened upper part. The stamens apparently are 10, free, with long filaments and rather short anthers. The ovary is hairy and fluted with five grooves: it is hard to distinguish the exact place where the gynophore passes into it. The style is as long as the ovary and ends in a large stigma. There are numerous ovules. For other points the original description may be consulted.

AAA. *STAMENS 16—60: the fruit relatively large with 2—many ovules in each loculus: the disc a circular bolster.*

C. *STAMENS 12—20: the ovules not more than 2 in each loculus.*

D. *STAMENS free*.....

CITRUS § *EREMOCITRUS.*

Here comes a very interesting Australian species *Atalantia glauca,* Benth., which is one of the bridges between *Atalantia* and *Citrus,* for which reason Swingle puts it into neither, but makes a genus for it,—*Eremocitrus* (Journ. Agric. Res. 2, 1914, p. 86). It is made into a preserve in Australia.

DD. *STAMENS polyadelphous*.....

CITRUS § *FORTUNELLA.*

Here come the Kumquats of Japan and China, which Swingle quite consistently treats, as he treated *Atalantia glauca,* making for them a new genus,—*Fortunella* (Journ. Wash. Acad. Sci. 5, 1915, p. 165). He enumerates six points against including them in *Citrus,* meaning thereby Eu-citrus, (1) that the ovary

is only 3—5-celled or rarely 6—7-celled, whereas that of Eu-citrus is 8—15-celled; (2) that they have only two collateral ovules in each loculus, against 4—12; (3) that in the cavernous stigma they have a few oil-glands; (4) that the underside of the leaf is pale and nearly veinless, with numerous deep glandular dots; (5) that the rind is edible and sweet; and (6) that the flower buds are more or less angular and small. He continues his definition by remarking that they differ from *Atalantia* in having twice as many stamens and in being in general agreement with *Citrus* in twigs, leaves, spines, flowers and fruit-characters.

The addition to *Fortunella* of the following species will be found to weaken his already too weak generic characters.

10. **Citrus polyandra**, Burkill: *Atalantia polyandra*, Ridley, Flora Mal. Penins. 5, 1925, p. 295: *Fortunella swinglei*, Tanaka MS. in Herb. Kew. This bush is a frequent plant in garden fences and in the neighbourhood of houses in the Territory of Malacca, and evidently occurs elsewhere in the Malay Peninsula. It produces globose fruits, with a small amount of pulp in them and no gummy secretion. They are five-celled, and with two ovules in each cell (it is not possible however to prove that this is the limit). The core may be hollow. The skin is thin, and not strongly aromatic. The whole serves as an acid flavouring under the name " limau pagar " or hedge lime.

The following specimens have been seen; six of them were inadvertently listed as specimens of *Atalantia roxburghiana* in the first volume of the Flora.

Perak. Lubok Merbau near Kuala Kangsar, in flower and with fruit in October, *Mohamed Haniff!* Negri Sembilan. Seremban, in fruit in December, *Ridley* 10052! Tampin, at the foot of the hill, in young fruit in May, *Goodenough* 1922! **Malacca.** Alor Gajah, in flower and fruit in October, *Burkill and Mohamed Haniff* 16375! Tebong, *Derry* 905! Selandar, in flower in January, *Derry* 1105! Ayer Panas, in fruit in November, *Goodenough* 1678! Malacca town towards Pringgit, in fruit in January, *Griffith* 540! near Malacca, *Ridley!* and in flower and fruit in May and June, *Maingay* 1099! and 1099A!

11. A plant with similar leaf-blades but shorter petioles! (**Dindings**, Ridley!).

CC. *STAMENS 16—20 and sometimes to 30, the ovules many in each cell* . . . . . .
CITRUS § *MICROCITRUS.*

Here come the Australian species of *Citrus* for which Swingle has proposed the genus *Microcitrus* (Journ. Wash. Acad. Sci. 5, 1915, p. 570). They have acid

fruits, either globose or elongated, and so much so that one bears the name of "Finger Lime."
CCC. *STAMENS 20—60.*

E. *STAMENS free.....CITRUS § PAPEDA.*

12. **Citrus hystrix,** DC. This is the "limau pĕrut" of the Malays, the "jeruk pĕrut" of the Sundanese. It is grown throughout Malaysia, and is quite common in Malaya in cultivation, and the fruits on sale as a material with which to wash the hair and also the body. The fruit of the commonest race is rather papillose. It is said that the pulp-cells carry a little oil in them. The very big wings upon the petioles characterise it and the next species.

EE. *STAMENS polyadelphous..... CITRUS § EU-CITRUS.*

F. *PETIOLE with a very large wing.*

13. **Citrus macroptera,** Montrouz: *Citrus hystrix,* Ridley, Flora Mal. Penins. 1, 1922, p. 358, not of DC. This species occurs from north-eastern India and south central China to New Caledonia, in several varieties. The type was described from the last-named island (Mem. Acad. Lyon, 10, 1860, p. 187). The China plant has received the names *Citrus cavaleriei,* Leveille, and *Citrus ichangensis,* Swingle. The Indian tree appears to deserve varietal rank. The foliage, as already remarked, is like that of *Citrus hystrix,* but the big very thick-skinned globose fruits are entirely different. The pulp-cells contain a secretion which in dried specimens may cause them to glisten. Because it is a wild tree, one Malay name for it is "limau hantu," ghost's or wild lime. A fruit brought to an Agricultural show in Seremban was called "limau abang" probably meaning red lime. Specimens have been seen from:—

Kelantan, Sungai Ketil, near Gua Musang, with fruit in August, *Henderson!* **Perak,** Kuala Dipang, with fruit in September, *Ridley* 9635! **Pahang,** without locality, but doubtless in northern Pahang, *Machado!* Kemasul forest reserve, with fruit in September, Hamid 10635! base of Gunong Senyum, with fruit in July, *Henderson* 22279! **Malacca,** Bukit Kedondong, sterile and a little doubtful, *Derry* 643!

An interesting figure of it is given in Fairchild's new book, *Exploring for plants,* (1930, p. 365), shewing the production of the large fruits to be in bunches. The photograph was taken in Sumatra.

FF. *PETIOLES always much smaller than the leaf-blade, and sometimes scarcely winged.*

G. *JOINT between the petiole and the leaf-blade not distinguishable.*

14. **Citrus medica,** Linn.: Ridley, Flora Mal. Penins. 1, 1922, p. 358, var. "limau susu" only. The race of *Citrus medica* most familiar to Europeans is the Citron. It reached the Mediterranean from Asia before the lemon and the orange. It had travelled westward as far as Persia before the invasion of that country by Alexander the Great, and Theophrastus knew of it: it became acclimatised in Italy at the commencement of the Christian era, and soon spread rapidly in Europe. Doubtless it had obtained a considerable distribution in Asia before it reached Persia. It exists in the Malay Peninsula in several races, and sometimes wild, when like other wild states of *Citrus,* the Malays call it "limau hantu," ghost's or wild lime. To them the most familiar race is "limau susu" or nipple lime, so called from the shape of the fruit. "Limau mata kĕrbau" or buffalo's eye lime is another name for this or a similar race. "Limau kĕrbau," buffalo's or big lime, seems to indicate a different race. "Limau pagar," hedge lime, and "limau kĕdangsa," have been recorded for it, but also for another species.

Apparently the Javanese have better races than the Malays: and one called "jĕruk katis" is used by them for candying.

Citrus medica, var. **sarcodactylis,** Swingle: Buddha's fingers: "limau jari," is a fixed abnormality, in which the carpels are separated. There is more than one race of it. The rind is very fragrant and the fruit of great repute among the Chinese for medical use, both in their own country and in the Malay Peninsula. Swingle thinks it originated in India, and was taken to China by Buddhist monks, because of its name, and because Bretschneider has failed to find mention of it in the chinese classics (Sargent, Plant. Wilson., 2, 1916, p. 142).

GG. *JOINT between the petiole and the leaf-blade easily distinguished.*

H. *SKIN of the fruit tight,—as a class "limau potong" among the Malays.*

15. **Citrus limon,** Burm., the Mediterranean Lemon. This native of India found its way westwards to Egypt in the third century and soon afterwards reached Sicily. Its flower buds are tinted with red as those of *C. medica*; and in this it differs from the species 17—24: its leaves are crenate, and the petiole is merely margined. It has been experimented with in Malaya, and has fruited; but there is no place for it in the markets against the true lime.

16. **Citrus limonia,** Osbeck, the Canton Lemon. This gives a globose yellow-skinned sour fruit, which is known in Canton as "li-mung" and "li-mu." Tanaka (Bull. Sci. Fak. Terkult. Kjusu Imp. Univ., 1, 1925, p. 125), pointing out how obviously malayan in origin these names are, suggests that the species came from India via Malaysia about 700—900 years ago; and adds that races persist in Malaysia.

17. **Citrus retusa,** Hort. apud Tanaka. A globose green orange, which, in common with others, may be called "limau hijau," and is also "limau asam," "limau masam," and "limau sambal." The petiole is very narrowly winged.

18. **Citrus microcarpa,** Bunge: *C. medica,* var. limau kasturi, Ridley, Flora Mal. Penins., 1, 1922, p. 358. The well-known "limau kĕsturi" or musk lime, is a race of this species. It has very small and very fragrant fruits which the Malays prefer to all others for making into sweetmeats. Also they salt it as a pickle.

There is a similar lime in the north of the Malay Peninsula, called "limau chuwit" or chancre lime, which appears to belong to this species.

19. **Citrus aurantifolia,** Swingle: *C. medica,* var. limau nipis, Ridley, Flora Mal. Penins., 1, 1922, p. 358. The true Lime. The common race of this species in Malayan gardens has globose fruits which turn a yellowish green when quite ripe; but an ellipsoid lime has been seen in Malacca. The lime of the West Indies is usually elongated.

20. **Citrus maxima,** Merr.: *C. decumana,* Linn.: *C. grandis,* Osbeck: *C. medica,* var. limau kadangsa, Ridley, Flora Mal. Penins., 1, 1922, p. 358. The pumelo and the shaddock; "limau Batawi" or Batavia lime, "limau Bali" or Bali lime, and "limau bĕsar" or big lime. Limau Bali is a race which was introduced by Sir Hugh Low. The Siamese seedless pumelo is a superior race in which the pollen is sterile; and when the trees of it are isolated seeds do not develop from failure to secure fertilisation. *C. maxima* is one of the most tropical of the genus, and is thoroughly at home in Malaya. Its fruits are produced singly, and are globose or nearly so, yellow or orange yellow, with a thick rind, and a great variability in the quality of the flesh (according to race): the pulp-cells contain mucilage rather than juice. The flower buds are white and the petioles have rather large wings.

21. **Citrus paradisi,** Macfad., the Grape-fruit. In appearance the fruit of this tree is very like a pumelo, but it is produced in clusters, is thinner skinned, and the pulp-cells contain juice instead of mucilage. It is now under experimental cultivation in the Peninsula.

22. **Citrus sinensis,** Osbeck, the Sweet Orange. This species reached the Mediterranean in the 16th century and gave rise there to the races—St. Michael or Blood, Joppa, Jaffa, etc., and in South America to the Washington Navel Orange. It is commonly called the Coolie Orange, down the China coast, from a name with this meaning. The Malays may call it "limau manis," sweet orange, or "limau potong," lime with a peel which requires to be cut off. But neither name is quite distinctive.

23. **Citrus aurantium,** Linn., the Seville Orange. This orange, the best for marmalade, reached the Mediterranean in the 9th or 10th century, and so before the arrival of the Sweet Oranges. It has been experimented with in the Malay Peninsula.

HH. *SKIN of the fruit loose,—as a class among the Malays* "limau kapas."

24. **Citrus mitis,** Blanco. A sour orange of the east of Asia, one race of which is the Calamondin of the Philippine islands. It has a thin yellow rind. The lower surface of the leaf recalls that of the Kumquats. "Limau nipis kapas" is a suitable descriptive name, recorded, but its application not noted satisfactorily.

25. **Citrus nobilis,** Lour., the Mandarin Orange (in contrast to the Coolie Orange), the Tangerine. This, being perhaps the most desirable of all the oranges, has often been experimentally planted in the Malay Peninsula, and is half-acclimatised in a race from China with characteristically cuneate lower halves to the leaves. The Nagpur Orange is another race of it which has been grown experimentally. The Satsuma Orange, which makes 7/10ths of the crops of Japan, is a variety. *C. nobilis* reached the Mediterranean only in the 18th century. Malay names for it are "limau japun" or japanese lime, and "limau wangkang," the last name indicating a fruit of the navel type.

In conclusion the opportunity may be taken of correcting an error in regard to the malay plant-name ĕmpĕnai. This name has been said to indicate an *Atalantia* (Journ. Roy. As. Soc. Straits branch, 30, 1897, p. 88) but an examination of the specimen from Perak which was collected under the name, shows that, whatever it is, it is not an *Atalantia;* nor is it allied closely.

NOTES ON GLUTA IN MALAYA.

By I. H. Burkill, M.A., F.L.S.

These notes are the result of being favoured with the loan of the specimens of the genus *Gluta* preserved in the herbaria of the Botanic Gardens, Singapore, and of the Forest Department, S.S. and F.M.S., in order that I might examine them alongside the material preserved in the Herbarium of the Royal Botanic Gardens, Kew. There are seven species involved.

1. **Gluta renghas,** Linn. Mantissa, 2, 1771, p. 293, by inadvertence as Gluta benghas: Jack in a letter to Wallich dated 1821 (printed in Journ. Roy. As. Soc. Straits Branch, 73, 1916, p. 230): Blume, Bijdragen, 1826, p. 1159 and Mus. Bot. Lugd. Bat., 1, 1850, p. 182, t. 39: Engler in DC. Monograph. Phanerogam., 4, 1883, p. 225: King in Journ. As. Soc. Bengal, 65/2, 1896, p. 480, or Materials 2, p. 788: Koorders and Valeton, Bijdrage tot kennis Boomsoorten van Java, in Mededeel. 'sLands Plantentuin, 17, 1896, p. 94: Ridley, Flor. Mal. Penins., 1, 1922, p. 527: Heyne, Nutt. plant. Ned. Ind., ed. of 1927, p. 972.

Stagmaria verniciflua, Jack in suppressed proof of Mal. Miscell., ex Hooker, Comp. Bot. Mag., 1, 1835, p. 267.

A tree, chiefly coastal, because along the coasts it finds the conditions by the side of water which it likes, but sometimes found inland: not infrequent on riverbanks near the sea in Java from the residency of Samarang westwards, more sparingly inland up to 900 ft., in Sumatra on the west coast and sometimes inland in small pure stands: recorded by Rumpf as in Celebes, and from Celebes he imported it into Amboina: in the Malay Peninsula only upon the coasts of Pahang and Trengganu and apparently also in Kelantan: further it is in northern Madagascar.

There is a specimen with flowers in Linnaeus' herbarium, written up in his own handwriting.

The proved Malayan localities are:—

State of **Kelantan.** Kamposa, in fruit and therefore not absolutely distinguishable from the next, *Gimlette!* State of **Trengganu.** Kuala Trengganu, *Holttum* 17672! State of **Pahang.** Pekan, *Burkill and Haniff* 17137! *Smith* 6706! Katapang on the Pahang river, *Ridley* 1228!

In the year 1890 Ridley procured a supply of seed of it from Pahang and raised a stock of seedlings in the Botanic Gardens, Singapore (Ann. Rep. Bot. Gard. and

Forest Dep., S.S. for 1890, p. 4), which in that year and the next, he planted out in various parts of the island (Rep. for 1890, p. 11 and for 1891, p. 9). Probably some remain; one 35 years old and several seedlings derived from it were standing in the Economic Gardens in the year 1925. The seedlings exhibited narrower leaves than the old tree. The ground where it grew, which was formerly salt marsh, but no longer saline, seems to have offered such a situation as the tree prefers.

The timber of this species is a bright red-brown and suggests mahogany. It makes very handsome furniture.

The fruit is large and subglobose, with irregular crests and protuberances particularly towards the base. It is 5 cm. in diameter.

The irritant properties of the latex are less intense than in some allied trees; but considerable.

2. **Gluta velutina,** Blume, Mus. Bot. Lugd. Bat. 1, 1850, p. 183.

Gluta coarctata, Hook. fil., Flor. Brit. Ind., 2, 1876, p. 22: Engler in DC. Monograph. Phanerogam. 4, 1883, p. 227: King in Journ. As. Soc. Bengal, 65/2, 1896, p. 482, or Materials, 2, p. 768: Ridley, Flora Mal. Penins., 1, 1922, p. 527.

Syndesmis coarctata, Griffith, Posthum. papers, Notulae, 4, 1854, p. 409, and Icones, t. 567, fig. 1.

A tree variously recorded as bushy, small and of moderate size; but in one very uncertain record as up to 100 ft. in height; apparently generally of lesser growth than *G. renghas,* and differing from it besides in the velutinous calyx and pedicels. It is found plentifully along the coasts of Cochinchina and Cambodia, in Siam about Bangkok, down the Siamese peninsula at Tapli; on the east coast of Sumatra and the north coast of Borneo and in the Malay Peninsula at the following localities:—

State of **Kedah.** Under Kedah Peak near Yen, *Ridley* 15086! State of **Perak.** Without locality, *Scortechini!* State of **Selangor.** Kuala Selangor, *Foxworthy* 11711! Kelambu Forest Reserve, *Yeob* 3288! Settlement of **Malacca.** Malacca town, *Griffith* 480 (=1120)! State of **Pahang.** Rompin river, *Soh* 15412! State of **Johore.** On the Muar river, close to the water, *Curtis* 3620! On the Batu Pahat river, Simpai Abang, *Lake and Kelsall!* Bukit Kayara on the Sungai Pauh, *Ridley!* Sungai Sempang Kanan, *Ridley* 11098! Sungai Sekudai, flowerless in the Kew specimen, but assigned by King, who collected it, to this species, *King and Hullett!* Settlement of **Singapore,** sterile and therefore uncertain, *Cantley!*

3. **Gluta Wrayi,** King, in Journ. As. Soc. Bengal, 65/2, 1896, p. 482, or Materials, 2, p. 768: Ridley, Flora Mal. Penins. 1, 1922, p. 528, as regards Wray's specimen, i.e. excluding the description of the fruit, which belongs to no. 4 below.

Gluta virosa, Ridley in Journ. Roy. As. Soc. Straits Branch, 75, 1917, p. 27: Flora Mal. Penins. 1, 1922 p. 528, excluding from both references the Selangor specimen, which seems to be a *Melanochyla,* and from the second the Simpit specimen, which is no. 4 below.

Mangifera sp., King in op. cit. p. 479, or Materials, 2, p. 765, a fruiting specimen.

A tall tree found in Penang and in the neighbourhood of Taiping and Kuala Kangsar and in the Dindings, the proved localities being:—

Settlement of **Penang.** Telok Bahang, a tree with ripe fruits in August, 1890, and in May, 1893, 25-30 ft. high, *Curtis* 3005! and without no.! Government Hill, with flowers in February, 1921, *Mohamed Haniff* 6999! Bukit Penara, large branching tree with flowers in March, *Curtis* 1527! State of **Perak.** Without locality, *Burn-Murdoch* 400! Larut plains by the Sungai Larut, in flower in July, 1888, Wray 2290! On Gunong Pondok, between 500 and 800 ft., a tree 50-70 ft. high with fruit in July, *Kunstler* 7744! Kati near Kuala Kangsar, a tree 30-40 ft. high in bud in January, *Mohamed Haniff* 14963! Dindings. Lumut, in flower in March, *Ridley* 7974!

Details have been given above of the condition in which the specimens were collected, because no one has yet obtained the flowers and the fruits from the very same tree, so that no one has proved that they are rightly brought together, though the exactness with which the leaves match, makes this all but certain.

The tree was collected first by Scortechini in 1885 in fruit, and King thought the specimen a *Mangifera.* When in 1888 Wray collected it in flower he described the flowering plant under the name adopted above, but failed to bring the fruiting specimen to its side. Ridley as will be explained under no. 4 below, obtained a different fruit in the Dindings, which in 1917 he ascribed to *G. Wrayi,* and having done that he logically attributed the true fruit to a new species.

The fruit of *G. Wrayi* is of the buff colour which the fruits of *G. renghas* and *G. velutina* have; but its shape is distinct; it has no tubercles or crests, and is elongated with a little flattening.

Burn-Murdoch ascribed the name rĕngas kĕrbau jalang or rengas of the untamed buffalo to it, but explained (Trees and Timbers, Mal. Penins. 2, 1912, p. 7) that this name may be applied to any of the more virulent species of rengas which possess red-brown wood. Of the timber he stated that it is a beautiful wood of a deep red colour with concentric black bands, but hardly used on account of the acute inflammation which the resinous juice sets up if it falls upon the skin, as may happen in felling.

In the publication referred to, he mentions rengas in the Trolak reserve, in Southern Perak; but seems to refer to *Melanorrhea* rather than to *Gluta*. Ridley's Selangor specimen is found to be a *Semecarpus:* and with these localities ruled out, we possess no indication that *G. Wrayi* extends southwards from Kuala Kangsar and Lumut.

4. To the next species it would be hazardous to give a name. It was collected in the Dindings (*Ridley* without number!) with fruit. In the year 1896 flowering specimens of a *Gluta* were collected at Lumut in the Dindings (Ridley 7974!): and there has been a confusion of the two. The latter is *G. Wrayi*, but the fruit of the former was described (Journ. Roy. As. Soc. Straits Branch, 49, 1907, p. 16) for that of *G. Wrayi*: and as a consequence of assigning the wrong fruit to *G. Wrayi*, the right fruit was described as that of a new species, *G. virosa* (Journ. Roy. As. Soc. Straits Branch, 75, 1917, p. 27). The fruit-wall and the leaves of the older specimen are preserved in the Botanic Gardens, Singapore, and the fruit was well described as oblong, red-brown, of a laterite colour, 4-5 inches long and 3 thick: the seed was sown in the Botanic Gardens and for eleven years at least grew there to a small tree, the subsequent fate of which is unknown. The leaves obtained from Simpit are like those of *G. elegans*, from which species of course the fruit sharply distinguishes the tree. The label calls it a big tree.

It may not be a *Gluta*, though it probably is.

5. **Gluta elegans,** Kurz ex Hook, fil., Flora Brit. Ind. 2, 1876, p. 22: and For. Flor. Burma, 1, 1877, p. 310: Engler in DC. Monograph. Phanerogam., 4, 1883, p. 225: King in Journ. As. Soc. Bengal, 65/2, 1896, p. 481, or Materials, 2, p. 767: Ridley, Flora Mal. Penins. 1, 1922, p. 527.

Syndesmis elegans, Wallich in Roxb. Flora Ind., ed. Carey, 2, 1824, p. 315.

This is a tree of about 30 ft. in height, very common in the hills, of Penang, where when in new leaf its violet colour is striking; but this quickly passes away. It produces flowers apparently at all times of the year; for they

have been collected in every month except April, July and November; but mostly however in February. The fruits germinate immediately they fall. They are black in colour, from 3.5 by 3 by 1.75 cm. to 5.5 by 4.25 by 3 cm.

Being so common it was one of the earlier plants collected in Penang, George Porter having sent it to Wallich in 1823. It was on Porter's specimens that he described it as *Syndesmis elegans*, being unable to indicate its true affinity as he had no fruit. From Penang it extends northwards to Tenasserim; but the Tenasserim plant differs a little, approaching *G. tavoyana*, and constitutes Hooker's var. *Helferi*. It is in Trengganu also.

The following specimens have been seen:—

Tenasserim, without locality, *Helfer* 1117! 1118! **Siam.** Circle or Pattani, Bachaw, *Kerr* 7214! State of **Kedah.** Rukit Dundong reserve, without flowers and therefore not absolutely certain, *Rahim* 12429! Settlement of **Penang,** without locality, *Maingay* 481! *Curtis* 1062! Batu Feringhi, *Ridley* 11948! West of Telok Bahang, *Burkill* 3387! Government Hill, *Porter* 1003! 9046! 9049! *King*! *King's collector* 1366! 4913! *Curtis' collector* 3278! *Curtis* 1552! *Ridley* 7096! 9228! *Mohamed Haniff*! Moniot's Road, *Burkill* 4588! Bukit Sua-Boi, *Curtis' collector*! Mount Olivia, *Mohamed Haniff*! State of **Trengganu.** Kuala Trengganu at Kampong Ladang, *Holttum* 7678!

The record of "Malacca" for it is an error.

If the back of the leaf of this species be examined, it will be observed that the larger lateral nerves arise from the midrib at an angle of 70-90° and are distinctly elevate. Curtis, through a native collector, obtained a specimen in which they arise at about 55° and are not distinctly elevate. This specimen bears the number 3278 and may be called var. *Curtisii*. It leads to *G. lanceolata*, which will be discussed next.

The Trengganu plant is between the type and var. *Curtisii*.

Kurz states that the wood is good for furniture and when steeped in ferruginous mud goes as black as ebony: he adds that it is used for building purposes, and with various mordants will dye colours between orange and black.

6. **Gluta lanceolata,** Ridley in Journ. Roy. As. Soc. Straits Branch, 49, 1907, p. 17, and Flora Mal. Penins. 1, 1922, p. 527.

This species is founded upon a single gathering made from a big tree at Balik Pulau in the Settlement of **Penang** in June, 1898 (Ridley 9465!). The tree was in flower at this time and also carried very young fruit. These fruits were too young for their mature shape to be foretold, and

the characters drawn from them, in the second of the descriptions quoted above, have no value. The leaves are very like the leaves of *G. elegans* var. *Curtisii*, but a little narrower: on their narrowness, on their being tufted, on a slight measure of minute hairiness on the calyx and on the record that the tree is a big one, rests its claim for specific rank.

7. **Gluta cambodiana,** Pierre, Flore forest. Cochinch., 1896, plate 368: Lecompte, Flor. gen. Indoch., 2, 1908, p. 20.

This species, which was founded by Pierre upon a single gathering in the Laos country, seems to be represented in a gathering from the interior of **Kelantan** (*Henerson* 19657! from the Sungai Keteh near Gua Ninik) but for certainty more material from both places is desirable, and especially material with fruit. The leaves and the flowers are identical; also in the type and in the Kelantan specimens the former are tufted on the ends of the stems and the latter towards the tops of the panicles. Pierre called his tree a small one: Henderson's tree is recorded as 70-80 ft. high.

Furthermore, additional material is required of *G. tavoyana* Hook. fil., which is as yet only inadequately diagnosed from *G. cambodiana* and *G. Wrayi.*

It is somewhat to be deplored that Linnaeus attached the name "renghas" to a species which is only one of a dozen and more trees entitled in malay to this name: for every *Gluta* and every *Melanorrhoea* is a rĕngas, equally with some species of *Buchanania,* of *Swintonia* and of *Semecarpus.* Their common character is the possession of a pale yellow resinous sap (black when dry) which causes dermatitis and pustular eruptions if it touches the skin. Those who live where the tree grows know its power to injure only too well, and Cerruti (My friends the savages, 1908, p. 209) states that his Sakai had a habit of destroying the trees when recognised. The malay word rĕngas becomes hangus in Semang, rangas in Sakai and in south-eastern Borneo, and reungas in sundanese and ingas in javanese. Ranjus, named by Logan (Journ. 1, 1847, p. 296) as a fruit eaten by the Sabimba of the coasts north of Singapore is probably the same. *G. renghas* and *G. velutina* are rĕngas ayĕr, because they grow by the side of water. Burn-Murdoch has stated that rĕngas kĕrbau jalang, *i.e.* rengas of the untamed buffalo, is a name given to the more virulent species. Its use however seems to be restricted to parts of Perak. There are other names with adjectival qualifications, but none of very precise application. The fact is that these trees are not in sufficiently general use in any way for names to be needed. The beautiful rich-red timber sometimes comes to market in single logs; but

we are without complete knowledge regarding its sources: *Melanorrhoea Wallichii* is perhaps the most common. Cubitt seems to suggest that resort to it is increasing (Rep. For. Adminis. F.M.S. for 1923, p. 15). Several authorities in the past have written of rĕngas in Malaya. Low in 1836 (Soil and Agri. Penang, p. 200) and Newbold in 1839 (Brit. Settlem. in Malacca, pp. 52 and 121) mentioned the timber as available; but it would be rash to assume what species they denoted. McNair in 1883 (Appendix to Cantley's Forest Rep., S.S., p. E-4) ascribed rengas to *G. velutina*; but there are reasons for thinking that this identification was a guess. That the timber of *G. renghas* is a beautiful wood is beyond contesting; but there is very little of it in the Peninsula.

The seeds of *G. renghas* and *G. velutina* can be eaten after roasting but are not much used anywhere. The former is in Madagascar: but at present there is no reason for thinking that it was taken there as a food plant. It would not be taken in any other way than in provision for a voyage. Its vernacular name in Madagascar is torotoro (Boivin had it as tourtour)—a name not recognisably malayan, and it seems that the fruit is without crests and ridges for which reason it is Engler's var. *turtur*. Writers assume that man took it to Madagascar, but have yet to explain how, if that is right, it differs varietally from anything known in Malaya.

HERPESTIS MONNIERA, *H. B. and K.* as pa-chi-t'ien.

Two very different plants have been identified as the chinese pa-chi-t'ien, the one *Herpestis Monniera*, a low-growing herb of the family Scrophulariaceae, the other *Polygala Reinii*, Franchet and Savatier, a somewhat larger plant of the family Polygalaceae. *Herpestis* is tropical; but the *Polygala* is not. Stuart in his *Chinese Materia Medica* (Shanghai, 1911, p. 388) and Hooper in the *Gardens Bulletin* (6, 1929, p. 111) assign the name to the *Polygala*: Read and Liu, following earlier authors, in their *Plantae Medicinales Sinensis* (Pekin, 1927, no. 97) assign it to *Herpestis Monniera.*

In the chinese herbalists' shops of the Malay Peninsula, Herpestis is invariably exposed for sale, and at any rate in Penang pa-chi-t'ien is the name used for it. But Herpestis cannot be the source of the small hard pieces of root-bark, described by Hooper, and under that name imported for chinese pharmacies in a dry state.

Thus it seems that two entirely different plants supply pa-chi-t'ien in Malaya.

I. H. BURKILL.

ERYTHROPSIS COLORATA, Burkill, comb. nov.

Erythropsis is a small genus of two species, which are so similar that *E. fulgens*, which reached Malaysia from India, was at one time regarded as a variety of the other species which is confined to India. The latter was described by Roxburgh as *Sterculia colorata*; and many botanists have left it in Sterculia. But in 1827 Lindley, in a journal which has become difficult to consult on account of its rarity,—Brande's *Quarterly Journal of Science, Literature and Art* (1, p. 112)—put forward in a tentative way the name *Erythropsis*, and did so again in 1829 in the *Botanical Register* (plate 1236), where he made his position clear by this remark,—"*Sterculia colorata*....if a distinct genus (*Erythropsis*) as I am inclined to believe is .... next of kin to *Sterculia*." In 1832 Schott and Endlicher in their *Meletemata botanica* (p. 33) definitely made *Erythropsis* a genus. They quoted Lindley but they called the species *Erythropsis roxburghiana*—a name which cannot be retained.

It is quite clear that Lindley must be regarded as the author of the genus: some botanists would prefer that it should be Lindley ex Schott and Endlicher (1832) than that it should be Lindley (1827) for Lindley's were not firm proposals. The two species are *Erythropsis colorata* (a new combination), and *E. fulgens*, Ridley (Flora Mal. Penins. 1, 1922, p. 277).

I. H. BURKILL.

VANDA X BOUMANIAE, J. J. S.

By Dr. J. J. Smith.

On a tour in the Malay Archipelago Mr. J. Laycock noticed in the orchid collection of Mr. and Mrs. Bouman, then residing on Alor, one of the lesser Sunda Islands, two specimens of a Vanda which he looked upon as a natural hybrid between *V. insignis*, Bl., and *V. limbata*, both of which occur on the said island. Mr. Laycock took back one of the specimens to Singapore and very kindly sent me a few pickled flowers, a dried leaf and tinted photographs. After having examined the material I think he is quite right although I did not see a specimen and consequently am not in a position to judge how far the plant differs in habit from the parents, which in this respect show distinct characteristics. Mr. Laycock, however, writes: "This is almost exactly intermediate between typical *V. insignis* and the form of *V. limbata* from the Lesser Sunda Islands."

The flower shows much likeness with *V. limbata*, but especially in the shape of the lip suggests the influence of *V. insignis*. The sidelobes are broader and just as in *V. insignis* more quadrate, the spur is much blunter than in *V. limbata*, whereas the pandurate midlobe, in contradistinction to *V. limbata*, is considerably widened in front and distinctly crenate as is the case in *V. insignis*; the anterior margin is slightly recurved.

Description. VANDA X BOUMANIAE, J.J.S., nov. hybr. nat.

Folia loriformia, apice inaequaliter obtusa biloba edentata, sicco c. 31 cm. longa, 2.8 cm. lata. Inflorescentiae axillares, laxe pluriflorae. Flores pulchri, carnosi, c. 4 cm. diam., sepalis petalisque leviter reflexis. Sepalum dorsale marginibus dimidii inferiore valde recurvis spathulatum, apice incurvulum, lamina parce laxeque undulatum, 2 cm. longum, explanatum ex ungue cuneato-quadrangulo in laminam elliptico-orbicularem rotundatam sensim dilatatum, 2. cm. longum, basi 0.4 cm., lamina 1.225 cm. latum. Sepala lateralia dorsali similia, leviter obliqua, convexa, lamina vix undulata, explanata ex ungue oblique cuneato-quadrangulo in laminam oblique orbiculari-ovatam obtusam dilatata, 2.1 cm. longa, ungue 0.5 cm. longo, basi 0.375 cm., apice fere 0.8 cm. lato, lamina 1.6 cm. longa, 1.5 cm. lata. Petala sepalis similia, subfalcatula, lamina laxe sed conspicue undulata, explanata oblique spathulata, ex ungue cuneato-quadrangulo in laminam oblique orbiculari-ovatam rotundatam dilatata, c. 2.1 cm. longa, ungue 0.7 cm. longo, basi

0.325 cm., apice fere 0.6 cm. lato, lamina 1.4 cm. longa, 1.325 cm. lata. Labellum horizontale carnosum, totum c. 2.85 cm., a loco insertionis 2.25 cm. longum; lobi laterales sub gynostemio porrecti, multo breviores, concavi, rotundato-subquadranguli, c. 0.53 cm. longi, bene 0.475 cm. alti; lobus intermedius multo major, porrectus, leviter incurvulus, convexus, panduratus, callo satis alto antice viso aequilateraliter trapeziformi apice leviter retuso antice tricostato ad basin inter lobos laterales, costis 5 longitudinalibus approximatis simplicibus in basi, exterioribus brevissimis, ceteris in c. 2/3 supra basin lobi intermedii evanescentibus, costa mediana ibidem furcata cum ramulis divergentibus apicem usque productis, c. 2.25 cm. longus, basi fere 1.1 cm., parte angusta 0.6 cm., antice 1.35 cm., latus, lobulis basilaribus brevibus latis obtusangule rotundatis, lobulo apicali multo majore, e basi contracta bene dilatato, orbiculari-sexangulata, plus minusve truncata, leviter convexa, basi excepta irregulariter crenata; calcar reversum, lateraliter compresso-conicum, obtusum, c. 0.65 cm. longum. Gynostemium conicum, apice contractum, c. 0.65 cm. longum, basi 0.75 cm. latum, clinandrio oblique truncato, reniformi cum costula longitudinali. Anthera plane cucullata, transverse ovalis, in rostrum latum quinquangulare obtusum producta, c. 0.35 cm. lata. Pollinia 2, a dorso compressa, oblique angulato-ovalia, dorso a latere oblique fissa, cum stipite lato apice contracto conduplicatoque obtuso basin versus angustato et glandula conspicua lata 0.4 cm. longa. Rostellum breve, latum bilobulum. Ovarium pedicellatum acute sexangulatum, c. 5.2 cm. longum.

Habitat: Alor Island (A. Bouman-Houtman, cult.).

Mr. Laycock describes the colour as follows:—"Lip deep pink, claw with 5 pale ridges, the two outer very short, the centre one extending into the limb. Side lobes of lip white faintly veined pink and with minute pink dots as in the Java form of *V. limbata*. Sepals and petals almost uniformly dark brown as in the Sunda Islands form of *V. limbata*, sepals with obscure paler reticulations. Column white, faintly tinged pink."

THE "PADANG" FLORA OF JEMAJA, IN THE ANAMBA ISLANDS, N. E. I.

By M. R. Henderson, F.L.S.

During a visit to the Anamba Islands in April 1928, an opportunity was taken to study a peculiar plant association found on the island of Jemaja.* Such associations are rather rare in the Malay Archipelago, and are known as "padangs," which seems a convenient term for them in the meantime.

The Jemaja padang is a sandflat on the coast just behind the large bay called Telok Mampoh on the charts, or, more exactly, that part of the bay known locally as Telok Padang. It is about half an hour's walk eastwards of Letong, the principal village in the island.

The Padang is perhaps a mile long, and for the greater part of its length is bordered on the seaward side by a river running parallel to the beach. Between the river and the sea is a narrow strip of cultivated coconut palms. The river makes a wide bend at the northern end of the padang and partly encloses it on the west. On the western edge of the padang are low hills, all cultivated and covered with coconut palms, which extend down into the padang in a straggling fashion, and end where there is swampy ground, which supports a number of sago palms.

The western half of the padang is slightly lower than the eastern, but yet not within the influence of the river at high tides. The river banks support a mangrove vegetation, but this does not extend beyond the actual banks and there is no trace of it in the padang itself. The soil of this lower western half is slightly damper than that of the eastern half, more compact, darker in colour and with a greater admixture of humus. The vegetation is lower and thicker, and there is a dense undergrowth of grasses, sedges and ferns.

The commonest fern—and it is extremely abundant-is *Pteridium aquilinum,* (L) *Kuhn, v. esculentum,* (Forst.), with *Blechnum indicum,* Burm. not quite so abundant and preferring damper spots. The bushes average 5-6 feet tall and are chiefly *Melastoma polyanthum,* Bl., *Rhodomyrtus tomentosa,* Wight, *Baeckia frutescens,* L., *Eugenia zeylanica,* Wight, very conspicuous with its clusters of opaque white fruit, *Archytaea Vahlii,* Choisy, and a *Timonius* which has not been properly identified, but which appears to be near

T. mutabilis, Boerl. *Flagellaria indica,* L., and a few plants of *Nepenthes Reinwardtiana,* Miq. climb over the bushes. A board track led through the padang, bordered by ditches which were almost dry at the time of my visit. In the ditches were found plants of *Utricularia minutissima,* Vahl, and *U. albina,* Ridl.

The eastern part of the padang is a few feet higher than the western and the soil here is a loose, very soft white sand of fine texture, so fine, in fact, that it squeaks underfoot as snow will do on a frosty day. The bushes here are taller, more widely spaced, the undergrowth of ferns and grasses disappears, and the spaces between the bushes are sparsely covered with plants of *Xyris complanata,* R. Br., and such sand-binding, creeping plants as *Hedyotis pinifolia,* Wall., *Mitrasacme polymorpha,* R. Br., *Desmodium ?trifoliastrum,* Miq., *Merremia tridentata,* Hallier, and *Evolvulus alsinoides,* Linn. The bushes here increase in height to an average of about 15 feet, with some larger trees, and are principally *Baeckia frutescens,* L., *Eugenia zeylanica,* Wight, *Daphniphyllum laurinum,* Baill., *Leucopogon malayanus,* Jack, *Garcinia rostrata,* B. & H., *Rhodamnia cinerea,* Jack, *Vaccinium bancanum,* Miq., var *tenuivenium,* J. J. S. (this was very common), *Podocarpus polystachyus,* R. Br., and *Cycas Rumphii,* Miq. *Ficus diversifolia* is also common, always as a terrestrial bush about 4 feet tall. One common small tree is *Cotylelobium flavum,* Pierre, nearly always bearing fruits at this time. This was collected in jungle on the lower slopes of the hills behind the bay, and is there a tall straight tree with brown bark, while the padang specimens are all low and bushy with whitey-grey bark.

Other species of less frequent occurrence are:—*Vitex pubescens,* Vahl., *Buchanania arborescens,* Bl., *Barringtonia macrostachya,* Kurz, *Eugenia lepidocarpa,* Wall., and small shrubs of *Ardisia crenata,* Roxb. *Cassytha filiformis,* L. twines on bushes of *Leucopogon* and *Baeckia,* and *Dendropthoe curviflora* is sparingly present. *Vitex pubescens* is often infested with *Amyema Beccarii.* Of still less frequent occurrance are *Fagraea auriculata* and plants of *Bromheadia* sp.

Similar associations occur in the Malay Peninsula on the east coast, but they do not seem to be so complex. The " heath " lands of Perlis and Setul are similar in some respects, the similarity being mostly due to the xerophytic character of the vegetation, but those (in Perlis) that I have seen are not so open and sandy as the Jemaja padang, being, in fact, in places, very swampy. The islands of Billiton and Bangka seem also to have somewhat similar " padangs," according to J. E. Teysmann in Natuurk.

Tydschr. Ned. Indie, Ser. VII, vol. 6, (1876), 210-293; to S. Kurz in the same publication, Ser. VI, 2, 148-258; and to Th. Valeton in Verslag van de gewone vergadering der Wis- en Natuurkundige Afdeeling der Kon. Acad. van Wetenschappen, Amsterdam, 1908, 120-126. The description of the "sand-padangs" in the last named publication, although short, indicates that they must be very similar to the sandy part of the Jemaja padang. *Drosera Burmanni*, however, was not found in Jemaja. It is recorded as occurring in the Billiton padangs, and it is found on the Perlis and Setul heaths.

There are distinct differences between the Jemaja padang flora and the flora of the adjacent sandy and rocky beaches. Common to both are *Melastoma polyanthum, Rhodomyrtus tomentosa, Podocarpus polystachyus*, etc., but *Baeckia frutescens* and *Leucopogon malayanus*, for instance are not found on the beach, while *Guettarda speciosa* and *Scaevola Koenigii* are absent from the padang.

This padang has apparently been interfered with by man to a very small extent. Tracks have been made through it, and possibly a little wood has been cut from the larger bushes or trees, but there has been no attempt at cultivation, and no grazing by cattle. Only one plant was seen which may possibly have been an alien—a fair sized tree of *Mangifera indica*. This was growing at the junction of two main pathways, where it gave a very welcome shade. Towards the southern end coconut palms begin to appear, the outliers of the plantations which surround the padang. It was evident that they were unsuited to the soil conditions and were not thriving, in contrast to the large plants of *Pandanus fascicularis*, Lam., which grew with them.

A list is given below of the plants collected on the padang, as it is thought to be fairly complete. The percentage of plants in flower or fruit, or both, was very much higher than in the nearby jungle.

I am indebted to the Director, Royal Botanic Gardens, Kew, and to the Director, Botanic Gardens, Buitenzorg, for indentifications of a number of plants; to Mr. R. E. Holttum for identifications of ferns; and to Dr. C. G. G. J. van Steenis for translations of Teysmann's, Kurz, and Valeton's papers mentioned above.

Plants growing on the lower, damper part of the Padang.

Archytaea Vahlii, Choisy. Common. Distributed throughout the Malayan Archipelago.

Baeckia frutescens, Linn. Commoner on the lower and damper spots, but extending into sandier places. W. Malaysia, China, Japan.

Rhodomyrtus tomentosa, Wight. Common, but not growing very tall. Widely distributed from India to Japan.

Melastoma polyanthum, Bl. Common. Distributed through W. Malaysia to the Philippines.

Timonius nr. mutabilis, Boerl. Not uncommon.

Ardisia littoralis, Andr. On the edge of river bordering the padang, hardly belonging to the padang proper. Indo-Malay, Philippines, China.

Utricularia albina, Ridl. In ditches by path. Ceylon, Tenasserim, Malay Peninsula.

Utricularia minutissima, Vahl. In ditches by path. Apparently not hitherto known outside the Malay Peninsula.

Clerodendron inerme, Gaert. On riverbank at edge of padang, not properly in the padang flora. Littoral from Trop. Africa to Polynesia.

Nepenthes Reinwardtiana, Miq. Climbing over bushes, not very common. Malay Peninsula, Sumatra, Bangka, Borneo.

Dianella ensifolia, Red. Sparingly present. India to Polynesia.

Flagellaria indica, Linn. Climbing over low bushes. Trop. Africa and Asia to Australia and Polynesia.

Fimbristylis pauciflora, R. Br. S. Asia to Australia.

Cladium undulatum, Thw. Ceylon to Malaya and Australia.

Eragrostis elongata, Jacq. Trop. Asia to Australia.

Schizachyrium semberbe, Nees. America, Africa, Trop. Asia.

(These two sedges and two grasses, along with the following ferns, formed the main part of the dense undergrowth in the damper places).

Pteridium aquilinum, Kuhn, v. esculentum (Forst). Very common, usually sterile. S. Asia, Australia.

Blechnum indicum, Burm. Slightly less common than the Pteridium, and preferring somewhat damper places. Trop. Asia and Australia.

Plants of the higher, sandier part of the padang.

Garcinia rostrata, B. & H. Not uncommon. Tenasserim, Malay Peninsula, Borneo, Java.

Cotylelobium flavum, Pierre. Common as a small bushy tree. Malaya Peninsula, Borneo.

Salacia flavescens, Kurz. Not very common. Tenasserim, Siam, Malay Peninsula.

Mangifera indica, Linn. One tree only seen. Doubtfully wild.

Buchanania arborescens, Bl. Common. Indo-Malaya to the Philippines.

Desmodium ?trifoliastrum, Miq. Creeping in dry sand in the open.

Ormosia bancana, Prain. Not common. Malay Peninsula, Bangka, Borneo.

Rhodamnia cinera, Jack. Common. Siam to Australia.

Eugenia caudatilimba, Merr. Not common. Hitherto known only from Sarawak.

Eugenia claviflora, Roxb. Not very common. India to Tenasserim and Malay Peninsula.

Eugenia lepidocarpa, Wight. Burma, Malay Peninsula, Sumatra.

Eugenia zeylanica, Wight. Common. India to Malay Peninsula, Java, Borneo.

Barringtonia macrostachya, Kurz. Not very common. Burma, Malay Peninsula, Borneo.

Pogonanthera pulverulenta, Bl. Sumatra, Malay Peninsula, Java, Borneo.

Hedyotis pinifolia, Wall. Creeping in open places in dry sand. India to W. Malaysia.

Gynocthodes sublanceolata, Miq. Not very common. Sumatra, Malay Peninsula, Borneo.

Psychotria viridiflora, Reinw. Sumatra, Malay Peninsula, Java, Borneo.

Leucopogon malayanus, Jack. Common. Malay Peninsula, Bangka, Sumatra, Borneo.

Vaccinium bancanum, Miq., var. tenuivenium, J. J. S. One of the commonest large bushes. The species in Malay Peninsula, Bangka, Borneo, the var. in Java.

Ardisia crenata, Roxb. Not very common. Indo-Malaya, China, Japan.

Olea maritima, Wall. Not common. ?Java, Cochinchina.

Jasminum bifarium, Wall. Twining on bushes in the open. W. Malaysia to the Philippines.

Evolvulus alsinoides, Linn. Creeping in open dry sandy places. Pantropic.

Merremia tridentata, Hallier. Creeping in sand between bushes. Africa, India, Malay Peninsula, Bangka.

Vandellia aff. hirsuta, Bth. In open sandy spots.

Mitrasacme polymorpha, R. Br. In open sandy spots. Indo-Malaya, China, Australia.

Fagraea auriculata, Jack. Seen occasionally. Malay Peninsula,Java, Philippines, Cambodia.

Aganosma marginata, G. Don. Not common. India, Malay Peninsula, Sumatra, Java, Philippines.

Tylophora villosa, Bl. Not common. Java.

Holarrhena pauciflora, Ridl. Not common. Hitherto known only from S. Siam and the north of the Malay Peninsula.

Hoya coronaria, Bl. Twining on bushes in the open. Sumatra and Malay Peninsula to N. Guinea.

Vitex pubescens, Vahl. A not infrequent small tree. Indo-Malaya, Philippines.

Henslowia buxifolia, Bl. Not very common. Malay Peninsula, Bangka, Borneo.

Daphniphyllum laurinum, Baill. Not uncommon. Sumatra, Malay Peninsula, Bangka, Borneo, Java.

Cassytha filiformis, Linn. Usually on bushes of Leucopogon and Baeckia. Pantropic.

Amyema Beccarii, Dans. Common on Vitex pubescens. Malay Peninsula, Borneo.

Dendropthoe curviflora, Dans. Not frequent.

Glochidion rubrum, Bl. S. Siam, Malay Peninsula, Java Philippines.

Ficus diversifolia, Bl., var ovoidea. Common, always as a terrestrial bush about 4 ft. tall. Malay Peninsula and Archipelago.

Bromheadia sp. An occasional plant seen.

Xyris anceps, Lam. Sparsely covering open dry sandy places. India to Malaya.

Pandanus fascicularis, Lam. Common in one place only. Mauritius, Trop. Asia.

Cycas Rumphii, Miq. Not uncommon. Nicobar Islands and Tenasserim to Australia.

Podocarpus polystachyus, R. Br. Not uncommon. Sumatra, Malay Peninsula, Borneo, Philippines.

Cyclophorus acrostichoides, (Forst.) Pr. On Eugenia sp. Ceylon, Malaysia to Polynesia.

Davallia denticulata, (Burm.) Mett. Under bushes, but not in deep shade. Madagascar to Polynesia.

Polypodium phymatodes, L. At bases of bushes, in shade. Old World Tropics.

Schizaea dichotoma, (L.) Sm. Under bushes, but not in deep shade. Madagascar to Polynesia.

Leucophanes densifolium, Mitt. Not abundant, but occurring in large tufts. Malaysia to Polynesia.

HALOPHILA SPINULOSA (R.Br.) Aschers.

Up to the present only one species of Halophila (*H. ovata*, Gaud.) has been recorded from the shallow seas round the coasts of the Malay Peninsula. Recently, however, *Halophila spinulosa* has been found. It was first collected by Mr. R. E. Holttum in shallow water at low tide off Pulau Ubin. Later, while dredging in about five fathoms off Pulau Tekong, in the same vicinity, the writer found it growing in mud. In November, 1930, it was collected by Mohamed Nur on the coast of Pulau Penyangat, in the Rhio Archipelago. Specimens of this gathering were sent to Dr. Beumée of the Botanic Gardens at Buitenzorg, Java, who identified it and remarked that this was the first time it had been collected in the Rhio Archipelago.

It does not appear to be common, having been recorded only from the Sunda Straits, the Philippines, and a few places on the coast of Queensland. The Singapore and Rhio specimens are all sterile, and all were found growing in mud. One at least of the Australian specimens is said to have been collected on coral reefs.

It is probable that it is not so rare as the scarcity of collections indicate. It is a submarine plant, probably never exposed even at low tide, and it is small and inconspicuous.

M. R. HENDERSON.

Rainfall.

At the Botanic Gardens, Singapore, during the year 1930. Reading taken at 9 a. m. and expressed in inches.

Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	...	...	...	·16	·24	...	...	...	·02	trace	1·34	1·44
2	...	...	...	...	1·42	...	...	...	...	·06	...	trace
3	·09	...	...	...	·51	trace	...	...	...	trace	·04	·09
4	1·12	...	·01	·52	2·27	...	...	...	...	·09	·20	·27
5	·35	...	...	2·48	...	...	...	...	·19	·08	·56	·83
6	...	...	...	2·62	...	·12	·28	·18	trace	1·13	·48	trace
7	·06	...	...	·13	·03	trace	...	...	1·98	...	...	·03
8	trace	...	·40	trace	·91	...	...	...	trace	trace	·01	·88
9	...	1·84	...	...	·19	...	...	...	...	...	...	...
10	1·13	1·91	·86	·02	·07	...	...	.	trace	...	...	trace
11	·42	...	·35	1·70	1·29	3·79	...	·24	·05	...	...	·17
12	...	...	·58	trace	·25	...	·01	..	·02	...	·02	·55
13	trace	...	trace	...	...	...	·10	...	1·29	...	...	...
14	·04	...	·15	1·34	...	1·38	...	·06	...	·25	·03	·43
15	·10	..	1 79	·09	...	...	...	...	·56	...	...	1·47
16	·30	·05	Nil	...	...	·11	...	...	...	...	·01	·31
17	trace	·03	1·31	...	·67	5·48	...	·22	...	1·33	2·38	trace
18	...	·16	·13	..	...	1·01	trace	...	...	1·57	1·65	·80
19	..	trace	...	·24	trace	·22	...	...	...	·07	·08	·13
20	·07	...	..	·16	·67	·11	trace	·01	...	...	·03	·50
21	...	...	...	·84	trace	trace	...	...	...	·25	·09	...
22	...	...	·13	·57	...	·31	...	...	...	·40	·39	·53
23	...	...	...	·26	...	...	·36	...	...	·21	trace	trace
24	...	..	trace	3·37	1·83	trace	·30	...	...	·72	·18	...
25	...	...	...	trace	·17	...	...	·31	·24	1·65	...	·89
26	...	·10	...	...	trace	...	...	·11	·23	·20	...	·01
27	·21	...	...	...	...	...	...	...	...	...	·56	·09
28	...	·29	...	...	...	...	·63	...	..	...	2·33	·02
29	...		...	trace	...	...	·14	...	2·50	·13	·15	·16
30	...		...	...	...	...	·07	...	·13	·23	·29	·07
31	...		trace		..		..	...		·64		·41
Total	3·89	4·08	5·71	14·50	10·52	12·53	1·89	1·13	7·21	9·01	10·82	10·08

Rainfall.

At the head of the Waterfall Gardens, Penang during the year 1930, in inches. Readings taken at 8 a.m. and credited to the date in which the twenty-four hours begin. Data kindly supplied by the Municipal Commissioners of George Town, Penang.

Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	·23	·59	...	...	...	...	...	...	...	·59	·04	·20
2	·03	·05	·11	...	1·91				1·59	1·56	...	·05
3	·10	·12	·29	...	...	...	·14	·03	2·57	2·25	·23	·26
4	...	·22	...	...	...	...	...	...	·04	2·42	·29	·15
5	...	...	·03	...	·04	...	...	...	3·68	·65	·09	1·44
6	·12		1·58	·47	·17			1·40	·03	·83	·03	·09
7	...	...	...	...	3·90	·17		·04	·40	·23	·60	. .
8	...	·11	...	...	4·92	·30	·58	...	·68	·29	...	·15
9	...	...	...	·06	·37	·52	·30	1·90	...	·03		1·00
10	...	...	·27	·22	1·18	·22	·03	·08	·93	·27	·94	1·35
11	·38	...	·03	·50	·12	2·10	19	·39	2·03	...	1·40	·30
12	·39	...	·23	...	·02	1·22	...	·52	·22	...	·57	·09
13	...	...	·12	·84	...	·25	1·28	·27	1·20	·23	·30	...
14	·07	...	·39	...	...	·43	·42	...	...	·55	·24	...
15	...	·06	·60	...	...	·23	...	·03	...	1·53	·20	.
16	...	...	·12	...	...	·68	...	·07	...	·10	·45	...
17	...	·55	...	·74	...	·54	...	1·00	...	·35	...	...
18	...	...	...	...	...	·08	1·02	...	...	·66	...	·03
19	·93	...	...	...	...	1·60	·48	...	...	...	...	·03
20	...	...	·17	...	...	·03	...	...	...	2·21	·14	·28
21	...	·10	·62	·19	...	·18	...	·20	...	·59	·07	...
22	...	·03	...	...	1·14		...	·75	...	1·37	...	·84
23	...	...	·60	·80	·17	·55	1·49	·60	...	·39	1·14	·27
24	...	...	...	·25	1·04	...	..	...	·83	·73	·73	·71
25	...	...	...	...	·32	·76	...	·03	3·80	1·12	...	·09
26	...	·05	·06	...	...	...	...	·12	·09	·75	...	...
27	...	...		·12	...	...	...	·13	...	·05	·10	·07
28	..	·20	·13	...	...	·02	·35	·03	2·15	·09	·16	·90
29	·17		·04	·55	...	...	...	·44	·03	·47	·47	·86
30	...		...	·13	...	...	...	1·99	·86	·06	·62	·06
31	...		2·53		...			·07		·79		·05
Total	2·42	2·08	7·92	4·87	15·30	9·88	6·28	10·09	21·13	21·16	8·81	9·27

Summary of Rainfall 1930.

	Singapore.				Penang.			
	No. of rainy days	Amount of Rain.		Longest spell without rain.	No. of rainy days.	Amount of Rain.		Longest spell without rain.
		Inches.	mm.			Inches.	mm.	
Jan.	16	3·89	99	6 days	9	2·42	62	9 days
Feb.	8	4·38	111	8 „	11	2·08	53	6 „
Mar.	13	5·71	145	6 „	18	7·92	202	3 „
April	20	14·50	369	3 „	12	4·87	123	5 „
May	17	10·52	268	5 „	13	15·30	389	9 „
June	13	12·53	319	6 „	18	9·88	251	6 „
July	10	1·89	48	5 „	11	6·28	159	4 „
Aug.	7	1·13	29	5 „	21	10·09	257	3 „
Sept.	14	7·21	183	9 „	17	21·13	537	10 „
Oct.	20	9·01	229	5 „	28	21·16	538	2 „
Nov.	21	10·82	275	3 „	21	8·81	224	3 „
Dec.	27	10·08	256	1 day	23	9·27	236	5 „
Total.		91·67	2331		202	119·21	3031	

Greatest amount in 24 hours 5·48″ or 139 mm.	4·92 inches or 125 mm.
Greatest amount in 48 hours 6·49″ or 165 mm.	8·82 inches or 224 mm.
Greatest amount in 72 hours 6·71″ or 170 mm.	9·19 inches or 233 mm.
Periods in which more than 5 ins. fell in 72 hours. 2 (April June)	3 (May, Sept., Oct.)
Periods in which less than ·02 ins. fell in 120 hours. 20 (Jan., Jan.-Feb., Feb. (3), Mar. (2), Apr., May, June (2), June-July, July (2), Aug. (3), Sept., Oct., Nov.)	9 (Jan., Feb., Apr., May (2), June, Sept. (2), Dec.)